Forest Protection in Canada, 1912

Clyde Leavitt

Commission of Conservation
Canada

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MR. JAMES WHITE

Commission of Conservation
CANADA

COMMITTEE ON FORESTS

FOREST PROTECTION IN CANADA, 1912

By

CLYDE LEAVITT, M. Sc.F.

Chief Forester, Commission of Conservation and Chief Fire Inspector, Board of Railway Commissioners

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TORONTO
1913

Committee on Forests

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and the Ex-officio Members of the Commission who represent the various provinces.

OTTAWA, CANADA, June 6, 1913

SIR :

I beg to submit the attached report of Clyde Leavitt, the Chief Forester of the Commission of Conservation. Mr. Leavitt in submitting his report said :

"I have the honour to submit the accompanying report as Chief Forester for the Commission for the year 1912. That portion of the report which relates to the railway fire situation in Canada was prepared principally in my capacity as Chief Fire Inspector for the Board of Railway Commissioners.

"Acknowledgments for the use of some of the photographs illustrating the report are due the U. S. Forest Service, Dominion Forestry Branch, Canadian Pacific Railway Forestry Branch, New York Conservation Commission, E J. Zavitz and H. C. Johnson."

Respectfully submitted,

JAMES WHITE,

Assistant to Chairman

HON. CLIFFORD SIFTON,
Chairman,
Commission of Conservation,
Ottawa

To Field Marshal, His Royal Highness Prince Arthur William Patrick Albert, Duke of Connaught and of Strathearn, K.G., K.T., K.P., &c., &c., Governor General of Canada

May it Please Your Royal Highness :

The undersigned has the honour to lay before Your Royal Highness the attached report on "Protection of Forests in Canada," which was prepared by Clyde Leavitt, Chief Forester of the Commission of Conservation.

Respectfully submitted,

CLIFFORD SIFTON,
Chairman

Ottawa, June 7, 1913

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Forest Protection in Canada

1912

Part I. Protection from Railway Fires

FROM the beginning of railway legislation in Canada, it has been recognized that the operation of coal-burning locomotives is a source of fire danger to adjacent property interests. The original Railway Act of 1903 contained definite recognition of the principle that railway companies must themselves bear the burden of protecting the public against fire loss due to railway operation. The extension of the application of this principle has been gradual but steady, until at the present time the provisions of the Railway Act and of the Regulations issued under them comprise the most extensive and the most efficient provisions to be found on this continent for the prevention and control of railway fires by the railways themselves.

The provisions of the Railway Act which specifically relate to the fire question are as follows:—

Extracts from the Railway Act of Canada and Amendments Thereto Relating to Fire Protection

Sec. 30, Railway Act, (Chap. 37, R.S. 1906.)

The Board may make orders and regulations :—

(*f*) With respect to the use on any engine of nettings, screens, grates and other devices, and the use on any engine or car of any appliances and precautions, and generally in connection with the railway, respecting the construction, use and maintenance of any fire-guard or works which may be deemed by the Board necessary and most suitable to prevent, as far as possible, fires from being started, or occurring, upon, along, or near the right of way of the railway,

(Amendment, by Sec. 2, Chap. 22, R.S. 1911.)

and may require the company to establish and maintain an efficient and competent staff of fire-rangers, equipped with such appliances for fighting, or preventing fires from spreading, as the Board may deem proper, and to provide such rangers with proper and suitable equipment to enable them to move from place to place along the line of railway with all due speed. The Board may require the company to maintain an efficient patrol of the line of railway and other lands in the vicinity thereof, to which fires may spread, and generally define the duties of the company, and the said fire-rangers, in respect thereof. The Board may require the company to make returns of the names of fire-rangers in its employ in the performance of the above duties, and at the places or areas in which they are from time to time engaged. For the purpose of fighting and extinguishing fires, the said fire-rangers may follow the fires which spread from the railway to, over, and upon the lands to which they may spread.

269. The Board may make regulations,—

(*b*) providing that coal shall be used on all locomotives instead of wood in any district ; and

(*c*) generally providing for the protection of property, and the protection, safety, accommodation and comfort of the public, and of the employees of the company, in the running and operating of trains by the company.

296. Every company shall cause thistles and all noxious weeds growing on the right of way, and upon land of the company adjoining the railway, to be cut down or to be rooted out and destroyed each year, before such thistles or weeds have sufficiently matured to seed.

297. The company shall at all times maintain and keep its right of way free from dead or dry grass, weeds and other unnecessary combustible matter.

298. (Enacted as Sec. 298 of principal Act, and other legislation repealed. Sec. 10, Chap. 22, 1911.) Whenever damage is caused to any property by a fire started by any railway locomotive, the company making use of such locomotive, whether guilty of negligence or not, shall be liable for such damage, and may be sued for the recovery of the amount of such damage in any court of competent jurisdiction ; Provided that, if it be shown that the company has used modern and efficient appliances, and has not otherwise been guilty of any negligence, the total amount of compensation recoverable from the company under this section in respect of any one or more claims for damage from fire or fires started by the same locomotive and upon the same occasion, shall not exceed five thousand dollars ; provided also that if there is any insurance existing on the property destroyed or damaged the total amount of damages sustained by any claimant in respect of the destruction or damage of such property shall, for the purposes of this subsection, be reduced by the amount accepted or recovered by or for the benefit of such claimant in respect of such insurance. No action shall lie against the company by reason of anything in any policy of insurance or by reason of payment of any moneys thereunder. The limitation of one year prescribed by section 306 of this Act shall run from the date of final judgment in any action brought by the assured to recover such insurance money, or, in the case of settlement, from the date of the receipt of such moneys by the assured, as the case may be.

"2. The compensation, in case the total amount recovered therefor is less than the claims established, shall be apportioned amongst the parties who suffered the loss, as the court or judge may determine.

"3. The company shall have an insurable interest in all property upon or along its route, for which it may be held liable to compensate the owners for loss or damage by fire caused by a railway locomotive, and may procure insurance thereon in its own behalf.

"4. The Board may order, upon such terms and conditions as it deems expedient, that fire guards be established and maintained by the company along the route of its railway and upon any lands, of His Majesty or of any person, lying along such route, and, subject to the terms and conditions of any such order, the company may at all times enter into and upon such lands for the purpose of establishing and maintaining such fire guards thereon, and freeing, from dead or dry grass, weeds and other unnecessary inflammable matter, the land between such fire guards and the line of railway."

It will be noted that these provisions fall naturally into six classes, namely :

(1) The use of fire protective appliances on locomotives.

(2) The establishment and maintenance of a staff of fire-rangers for special patrol work.

(3) The regulation of locomotive fuel.

(4) The clearing of rights of way.

(5) The financial responsibility of railway companies for fire loss due to railway locomotives.

(6) The construction and maintenance of fire guards along railway lines.

The first and fourth of these were included in the original Railway Act of 1903, and have been carried forward without change into the present Railway Act.

The sixth, relating to fire guards, was included in the Railway Act of 1903, in the paragraph relative to the use of fire-protective appliances on locomotives, and was later expanded, in 1909, and re-enacted in 1911, as shown in subsection 4 of Section 298 above. The modification gave the Board authority to specify the conditions under which fire guards shall be constructed, with especial reference to entry for that purpose upon the lands of His Majesty or any other person.

The financial responsibility of railway companies for fire losses was included in the original Railway Act of 1903, and was slightly modified in the revision of the Act of 1906 ; it was again amended in 1909, then in 1910, and was re-enacted in its present form in 1911, as shown in Subsections 1, 2, and 3 of Section 298 above. The later action of the Board in regulating the kind of locomotive fuel to be used was forecast in Section 269, enacted in 1906.

The requirement as to the establishment of special patrols by railway companies, was enacted in 1911, due in considerable part to the influence of the Commission of Conservation. This is the most progressive, perhaps the most radical requirement of all, since in this respect the Railway Act takes advanced ground over any other railway

legislation on the continent. So far as is known, neither the Federal nor any State Government in the United States has enacted legislation along this line which approaches this so far as placing the burden of fire protection on the railways themselves is concerned. In Canada, action of a closely similar character has since been taken in the Provinces of British Columbia and Quebec as to railway lines not subject to the jurisdiction of the Board of Railway Commissioners. An act in New Brunswick would make it possible for special patrols to be required on railways chartered by the Province and therefore not subject to the Board, but this Act has not been enforced.

It will be noted, that, by the terms of the Railway Act above quoted, the issuance of orders and regulations by the Board is required, in order to make effective the provisions as to fire-protective appliances, special patrols, the regulation of locomotive fuel, and the construction of fire-guards. The latter question occupied the attention of the Board from a very early date, and hearings were held in the west on the subject of fire-guards as early as 1904. The question of fire-protective appliances on locomotives was also given early consideration, as was that of the great fire danger caused by the use of lignite coal as locomotive fuel. After most careful consideration, an Order (No. 3245) was issued under date of July 4th, 1907, by the late Chief Commissioner Killam, fully covering the question of fire-protective appliances on locomotives, prohibiting the use of lignite coal as locomotive fuel and requiring the construction of fire-guards along railway lines in Alberta and Saskatchewan.

Complications having arisen as to the enforcement of the provisions of this Order relating to the construction of fire-guards, these provisions were rescinded by the issuance of a new Order (No. 15995) dated February 16, 1912, modifying the procedure in case of objection by a private owner to the construction of fire-guards across his land, and making some other changes of a minor nature in the terms of the Order.

Application by British Columbia Government

THE first great stimulus, which ultimately brought about the next and so far the final revision of the fire regulations, was given by the Government of British Columbia, when it made application to the Board in 1909, for the issuance of regulations, which should provide additional and adequate protection from railway fires to the great forest resources of that Province. It was shown that the use of fire-protective appliances on locomotives, as required by the 1907 order of the Board, while highly essential, did not provide sufficient protection. The requirement for the construction of fire-guards applied only

OLD BURNS, YAHK RANGE, WEST OF GOATFELL, B.C.
Lower slopes restocking, upper slopes not restocking.

FIRE DANGER AND DAMAGE ADJACENT TO SAWMILL AND RAILWAY LINE
Note burned slopes and large accumulation of inflammable sawmill débris.

to Alberta and Saskatchewan, and conditions were such that extension to British Columbia was impracticable.

The application of the British Columbia Government was based upon the preliminary report of the Royal Commission of Inquiry on Timber and Forestry, which conducted investigations during 1909 and 1910. The chief result of the work of this Commission was the enactment of the present Forest Law of British Columbia, which places that Province in the lead as to forestry administration in Canada. Much credit is also due this Commission for initiating the action which led to the requirement that railways should establish patrols wherever necessary, at their own expense. The following extract from the report of the Commission* indicates clearly the urgent need for action:—

The Control of Railways

IT is a truism that railways are the most frequent cause of fire in any timber areas through which they pass. The great majority of witnesses examined by us were somewhat emphatic upon this point.

"Though there seems to be considerable doubt as to the power of the Provincial Government to enforce regulations against any railway company that is under Dominion jurisdiction, your Commissioners urge, nevertheless, that every effort should be made to minimise the dangerous conditions that exist at present. Stringent regulations should provide during the dry months for a thorough patrolling of the railway track after the passing of every train through a timbered district; the provisions of the railway Act, concerning the clearing of the right of way, should be embodied in regulations that should be enforced; wherever practicable oil should be substituted for other locomotive fuel in timber sections during each summer, while elsewhere the use of the most modern and efficient spark arresters, and their frequent renewal, should be insisted on. Fire wardens should be empowered to inspect any locomotive at any stopping place should they have reason to suspect any failure to comply with this last regulation. The aid of the Railway Commission should be invoked should the enforcement of these essential provisions for the safety of forests prove, in the case of any company, to be beyond the jurisdiction of the Provincial Government.

"Your Commissioners are pleased to report, that, in an interview with the Railway Commission, they obtained an unqualified promise that provincial fire wardens, whose duties should include the examination of locomotives, the patrolling of the right-of-way of any railway, or the supervision of new construction in timbered districts, and whose names should be submitted to the Railway Commission, would immediately be given power to act as officials of this Commission in all matters concerning the prevention and the control of fires.

* Pages 61, 62.

"We, therefore, urge, that, as soon as the formation of the Department of Forests is undertaken, the Government should take the matter up with the Railway Commission, so that, even for the season of 1911, provincial fire wardens may be clothed with full authority.

"Railway construction, on a large scale, is about to take place in the Province. Unless an efficient patrol system is put in force by the Government, railway construction will spell forest destruction. For example, there is said to be heavy timber the whole way from Tete Jaune Cache to Fort George, covering a very large area. In evidence given before the Commission a witness who had cruised in that belt of timber says, 'unless there are regulations as to the construction of the Grand Trunk Pacific that country is going to be burnt up. It is virgin forest and very inflammable. There should be special legislation.' It is a matter of common knowledge that the blackened record of railroad construction in the past justifies to the full forebodings such as these."

As a result of the application, hearings were held by the Board at various points, from the filing of the application by British Columbia until May, 1912. It appeared from the testimony presented at the various hearings that the establishment of special patrols by railway companies was the most essential measure needed, these patrols to be established through forest sections where the fire danger was greatest.

The matter was taken up in the intermediate stage by the Commission of Conservation, and the enactment was secured of the 1911 amendment to section 30 of the Railway Act, above quoted, providing for railway patrols. In pursuance of a co-operative arrangement between the Chairman of the Commission of Conservation, the Hon. Clifford Sifton, and the Chief Commissioner of the Board of Railway Commissioners, the late Hon. J. P. Mabee, an expert, Mr. F. E. Olmsted was employed by the Commission of Conservation to draft a set of tentative regulations, including a revision of existing regulations, so far as necessary. This tentative draft was the subject of the last hearings on the application of British Columbia, which were held at Toronto and Ottawa, in April and May, 1912.

After very careful consideration of the matter, action was taken May 22 through the issuance of the following Order :—

BOARD OF RAILWAY COMMISSIONERS FOR CANADA

Order No. 16570.

Wednesday, the 22nd day of May, A.D., 1912.

D'ARCY SCOTT,
Assistant Chief Commissioner
JAMES MILLS,
Commissioner
S. J. McLEAN,
Commissioner
A. S. GOODEVE,
Commissioner

IN THE MATTER OF the Orders of the Board prescribing regulations to be adopted by Railway Companies for the prevention of fires, and the application of the Lands Department of the Government of the Province of British Columbia for an Order regulating the operation of railway locomotives within the Province of British Columbia having regard to the spreading of fires upon lands adjacent to the company's right-of-way. File No. 4741-2.

UPON the hearing of the application at the Sittings of the Board held in the City of Toronto on April 30th, 1912, the Government of the Province of British Columbia, the Canadian Pacific Railway Company, the Grand Trunk Pacific, the Grand Trunk, and the Canadian Northern Railway Companies, the Conservation Commission, and the Canadian Forestry Association being represented by Counsel at the hearing, the Dominion Forestry Reserves also being represented, and what was alleged,—and upon the reading of what has been filed on behalf of the interests affected, and in pursuance of the powers conferred upon the Board by Sections 30 and 269 of the Railway Act and all other powers possessed by it in that behalf—

IT IS ORDERED AS FOLLOWS :—

1. Order No. 3245, dated July 4th, 1907 ; Order No. 3465, dated August 14th, 1907 ; Order No. 8903, dated December 15th, 1909 ; and Order No. 15995, dated February 16th, 1912, be, and they are hereby rescinded.

2. Until further order, every railway subject to the legislative authority of the Parliament of Canada, under construction or being operated by steam, shall, unless exempted by a special order of the Board, cause every locomotive engine used on the said railway, or portion of railway, being constructed or operated by it, to be fitted and kept fitted with netting mesh as hereinafter set forth, namely :

(*a*) On every engine equipped with an extension smoke box, the mesh shall be not larger than 2½ x 2½ per inch of No. 10 Birmingham Wire Gauge, and shall be placed in the smoke box so as to extend completely over the aperture through which

the smoke ascends, the openings of the said mesh not to exceed a quarter of an inch and one sixty-fourth (that is, seventeen sixty-fourths) of an inch to the square.

(*b*) On every engine equipped with a diamond stack, the mesh shall be not more than 3 x 3 per inch of No. 10 Birmingham Wire Gauge, and shall be placed at the flare of the diamond of the stack, so as to cover the same completely,—the openings of the said mesh not to exceed three-sixteenths and one sixty-fourth (that is, thirteen sixty-fourths) of an inch to the square.

3. Every such railway company shall cause :—

(*a*) The openings of the ash pans on every locomotive engine used on the railway, or portion of railway, operated or being constructed by it, to be covered, when practicable, with heavy sheet iron dampers ; and, if not practicable, with screen netting dampers 2½ x 2½ per inch of No. 10 Birmingham Wire Gauge,—such dampers to be fastened either by a heavy spring or by a split cotter and pins,—or by such other method as may be approved by the Board.

(*b*) Overflow pipes from lifting injectors, or from water pipes from injector-delivery pipe, or from boiler, to be put into the front and back part of the ash pans and used from the first day of April to the first day of November, or during such portion of this period as the Board may prescribe, for wetting ash pans.

4. Every such railway company shall provide inspectors at terminal or divisional points where its locomotive engines are housed and repaired ; and cause them,—in addition to the duties to which they may be assigned by the officials of the railway companies in charge of such terminal or divisional points,—

(*a*) To examine, at least once a week—

(1) The Nettings ;
(2) Dead Plates ;
(3) Ash Pans ;
(4) Dampers ;
(5) Slides ; and
(6) Any other fire-protective appliance or appliances used on any and all engines running into the said terminal or divisional points.

(*b*) To keep a record of every inspection in a book to be furnished by the railway company for the purpose, showing—

(1) The numbers of the engines inspected ;
(2) The date and hour of day of such inspection ;
(3) The condition of the said fire-protective appliances and arrangements ; and
(4) A record of repairs made in any of the above mentioned fire-protective appliances.

The said book to be open for inspection by the Chief Fire Inspector or other authorized officer of the Board.

(*c*) In case any of the said fire-protective appliances in any locomotive are found to be defective, said locomotive shall be

removed from service and shall not, (during said prescribed period), be returned to service, unless and until such defects are remedied.

(*d*) Every such railway company shall also appoint one or more Special Inspectors, as may be needed whose duties shall be to make an independent examination of the fire-protective appliances on all the locomotives of such company, at least once each month, and report the conditions of such fire-protective appliances direct to the Chief Mechanical Officer of the railway company, or other chief officer, held responsible for the condition of the motive power of the said Company.

5. Any authorized officer of the Board, shall have power to inspect at any time any and all locomotives, and may remove from service any locomotive which is found to be defective in the said fire-protective appliances ; and any such locomotive so removed from service, shall not (during the said prescribed period), be returned to service, unless and until such defects are remedied.

6. No employee of any such railway company shall—

(*a*) Do, or in any way cause, damage to the netting on the engine smoke-stack or to the netting in the front end of such engine ;

(*b*) Open the back dampers of such engine while running ahead, or the front dampers while running tender first ;

(*c*) Or otherwise do or cause damage or injury to any of the fire-protective appliances on the said engine.

7. No such railway company shall permit fire, live coals, or ashes, to be deposited upon its tracks or right-of-way outside of the yard limits, unless they are extinguished immediately thereafter.

8. No such railway company shall burn lignite coal on its locomotive engines as fuel for transportation purposes, unless otherwise ordered by the Board,—lignite coal consisting of and including all varieties of coal between peat and bituminous with a carbon-hydrogen ratio of 11.2 or less, such ratio being based on analysis of air-dried coal.

9. Every such railway company shall establish and maintain fire-guards along the route of its railway as the Chief Fire Inspector may prescribe. The nature, extent, establishment, and maintenance of such fire-guards shall be determined as follows:

(*a*) The Chief Fire Inspector shall each year prepare and submit to every such railway company a statement of the measures necessary for establishing and maintaining the routes of such railways in a condition safe from fire, so far as may be practicable.

(*b*) Said measures may provide for the cutting and disposal by fire, or otherwise, of all or any growth of an inflammable character, and the burning or other disposal of debris and litter, on a strip of sufficient width on one or both sides of the track ; the ploughing or digging of land in strips of sufficient width on one or

both sides of the track, and such other work as may, under the existing local conditions and at reasonable expense, tend to reduce to a minimum the occurrence and spread of fire.

(*c*) Said statements of the Chief Fire Inspector shall be so arranged as to deal with and prescribe measures for each separate portion of such railway upon and adjacent to which the fire risk calls for specific treatment. The intention shall be to adjust the protective measures to the local conditions and to make the expense proportionate to the fire risk and the possible damage.

(*d*) Said statements of the Chief Fire Inspector shall prescribe dates on or within which the foregoing protective measures shall be commenced and completed, and the fire-guards maintained in a clean and safe condition.

(*e*) No such railway company shall permit its employees, agents, or contractors to enter upon land under cultivation, to construct fire-guards, without the consent of the owner or occupant of such land.

(*f*) Wherever the owner or occupant of such land objects to the construction of fire-guards, on the ground that the said construction would involve unreasonable loss or damage to property, the Company shall *at once* refer the matter to the Board, giving full particulars thereof, and shall in the meantime refrain from proceeding with the work.

(*g*) No agent, employee, or contractor of any such railway company shall permit gates to be left open or to cut or leave fences down whereby stock or crops may be injured, or do any other unnecessary damage to property, in the construction of fire-guards.

10. . In carrying out the provisions of Section 297 of the Railway Act, which enacts that "the company shall at all times maintain and keep its right-of-way free from dead or dry grass, weeds, and other unnecessary combustible matter," no such railway company or its agents, employees, or contractors shall, between the first day of April and the first day of November, burn or cause to be burned any ties, cuttings, debris, or litter upon or near its right-of-way, except under such supervision as will prevent such fires from spreading beyond the strip being cleared. The Chief Fire Inspector or other authorized officer of the Board may require that no such burning be done along specified portions of the line of any such railway, except with the written permission or under the direction of the Chief Fire Inspector or other authorized officer of the Board.

11. The railway company shall provide and maintain a force of fire-rangers fit and sufficient for efficient patrol and fire-fighting duty during the period from the first of day April to the first day of November of each year ; and the methods of such force shall be subject to the supervision and direction of the Chief Fire Inspector or other authorized officer of the Board.

12. The Chief Fire Inspector shall, each year, prepare and submit to each and every railway company a statement of the

measures such railway companies shall take for the establishment and maintenance of said specially organized force. Said statements among other matters may provide for—

(*a*) The number of men to be employed on the said force, their location and general duties, and the methods and frequency of the patrol ;

(*b*) The acquisition and location of necessary equipment for transporting the said force from place to place, and the acquisition and distribution of suitable fire-fighting tools ; and

(*c*) Any other measures which are considered by him to be essential for the immediate control of fire and may be adopted at reasonable expense.

13. Whenever and while all the locomotive engines used upon any such railway, or any portion of it, burn nothing but oil as fuel, during the aforesaid prescribed period, under such conditions as the Board may approve, the Board will relieve the said railway of such portions of these regulations as may seem to it safe and expedient.

14. The sectionmen and other employees, agents, and contractors of every such railway company shall take measures to report and extinguish fires on or near the right-of-way, as follows :

(*a*) Conductors, engineers, or trainmen who discover or receive notice of the existence and location of a fire burning upon or near the right-of-way, or of a fire which threatens land adjacent to the right-of-way, shall report the same to the agent or persons in charge at the next point at which there shall be communication by telegraph or telephone, and to the first section employees passed. Notice of such fire shall be also given immediately by a system of warning whistles.

(*b*) It shall be the duty of the agent or person so informed to notify immediately the nearest forest officer and the nearest section employees of the railway, of the existence and location of such fire.

(*c*) When fire is discovered, presumably started by the railway, such sectionmen or other employees of the railway as are available shall either independently or at the request of any authorized forest officer proceed to the fire immediately and take action to extinguish it ; provided such sectionmen or other employees are not at the time engaged in labours immediately necessary to the safety of trains.

(*d*) In case the sectionmen or other employees available are not a sufficient force to extinguish the fire promptly, the railway company shall, either independently or at the request of any authorized forest officer, employ such other labourers as may be necessary to extinguish the fire ; and as soon as a sufficient number of men, other than the sectionmen and regular employees are obtained, the sectionmen and other regular employees shall be allowed to resume their regular duties.

NOTE.—Any fire starting or burning within 300 feet of the railway track, shall be presumed to have started from the railway, unless proof to the contrary is furnished.

15. Every such railway company shall give particular instructions to its employees in relation to the foregoing regulations, and shall cause appropriate notices to be posted at all stations along its lines of railway.

16. Every such railway company allowing or permitting the violation of, or in any respect, contravening or failing to obey any of the foregoing regulations, shall, in addition to any other liability which the said company may have incurred, be subject to a penalty of one hundred dollars for every such offence.

17. If any employee or other person included in the said regulations, fails or neglects to obey the same, or any of them, he shall, in addition to any other liability which he may have incurred, be subject to a penalty of twenty-five dollars for every such offence.

(Sgd.) D'ARCY SCOTT,
Assistant Chief Commissioner

Board of Railway Commissioners for Canada

BOARD OF RAILWAY COMMISSIONERS FOR CANADA.

Examined and certified as a true copy under Section 23 of "The Railway Act,"

A. D. CARTWRIGHT,

Secretary of Board of Railway Commissioners for Canada.
OTTAWA, May 28th, 1912.

Improvements Over Previous Orders

In this Order, the provisions of preceding orders relative to fire-protective appliances, the use of lignite, and the construction of fire-guards are, in substance, included, with the following additions:—

Railways under construction are included in the scope of the Order, in addition to those under operation ;

A more thorough inspection of fire-protective appliances by railway employees ; (Reg. 4)

Provision for removing from service locomotives found defective as to fire-protective appliances, pending repair ; (Regs. 4 and 5)

Provision requiring immediate extinguishment of fire, live coals or ashes deposited upon rights-of-way; (Reg. 7)

Improved definition of lignite coal (Reg. 8)

Complete elasticity in administering the requirement for the construction of fire-guards, as to how, when, and where these shall be constructed ; (Reg. 9)

Regulation of burning of inflammable material along rights-of-way under Sec. 297 of the Railway Act; (Reg. 10)

RIGHT OF WAY IN SOUTHEASTERN MANITOBA BADLY IN NEED OF CLEARING

RIGHT-OF-WAY IN SOUTHEASTERN MANITOBA FAIRLY WELL CLEARED

Provision for a force of fire-rangers to be maintained by the railway companies, in accordance with the direction of the Chief Fire Inspector ; (Regs. 11 and 12)

Partial relief from the requirements of the Act, in case oil is used as locomotive fuel ; (Reg. 13)

Reporting and extinguishing of fire by regular railway employees ; (Reg. 14).

Jurisdiction.—It should be understood that the provisions of the Railway Act and of Order 16570 affect only railways which are subject to the jurisdiction of the Board of Railway Commissioners. These, however, comprise a very large percentage of the total railway mileage of Canada. There are three classes of railways in this category :

(1) Those chartered by the Dominion Government.

(2) Provincial chartered lines which by Act of Parliament have been declared works for the general advantage of Canada.

(3) Provincial chartered lines which have been leased by, and are operated as, a part of a line, or system, which is subject to the jurisdiction of the Board under (1) or (2).

Of railways owned by the Dominion Government, the Intercolonial is operated by a separate commission and is not subject to the Board. Neither is that portion of the National Transcontinental railway, which is being operated as a government line by the National Transcontinental Railway Commission. However, as soon as any portion of the National Transcontinental is turned over to the Grand Trunk Pacific Railway Company for operation, as provided by law, such portion then becomes subject to the jurisdiction of the Board, as a part of the Grand Trunk Pacific Railway system.

The Temiskaming and Northern Ontario railway is owned and operated by the Ontario Government, and is therefore not subject to the jurisdiction of the Board.

The British Columbia extension of the Canadian Northern system is incorporated, under Provincial legislation, as the Canadian Northern Pacific railway, and is not subject to the jurisdiction of the Board. The Provincial Forest Act, however, provides amply for such cases in British Columbia.

Organization of Patrol Work.—Soon after the issuance of Order 16570, the writer, who had previously been appointed Forester to the Commission of Conservation, was also appointed Chief Fire Inspector to the Board of Railway Commissioners. This action was taken in pursuance of the plan of co-operation agreed upon between Hon. Mr. Sifton and the late Chief Commissioner Mabee.

The organization of the work in the west was taken up immediately, with the idea of securing as adequate protection as possible during the balance of the fire season. Attention was particularly needed with regard to the establishment of patrols, since the railway companies were already proceeding with plans for fire-guard construction in the prairie sections, under the previous Order ; and since the requirements as to fire-protective appliances on locomotives had since 1907 been efficiently administered under the direction of the Chief Operating Officer of the Board, who still retains charge of this feature of the fire work.

In connection with the previous hearings before the Board, the Government of British Columbia had prepared a plan of patrols covering lines in British Columbia with the exception of the Railway Belt*; and a similar plan had been prepared by the Forestry Branch, Department of the Interior, for lines in the Railway Belt and in the forested sections of Alberta, Saskatchewan and Manitoba. These plans were made the basis of a series of conferences between designated representatives of the railway companies, on the one hand, the Chief Fire Inspector of the Board and designated representatives of the British Columbia Government, and of the Forestry and Parks Branches, Department of the Interior, on the other. Following these conferences, which were held during the month of June, 1912, letters of instruction to the railway companies affected were written by the Chief Fire Inspector, embodying the various measures to be adopted under regulations 11 and 12 of Order 16570, with particular reference to the establishment of special patrols by railway companies. The aim was to provide an efficient system of fire protection at a minimum of cost to the railway companies.

Efficient protection is obviously not only essential to the public interest, but is the only correct policy from the point of view of the railways themselves. From the purely selfish point of view, this is true because, with rapidly increasing stumpage values, timber owners are no longer willing to sit quietly by and allow their property to be destroyed without any attempt at recourse. The comparatively recent granting of several verdicts for very large sums against railway companies for fire damage caused by locomotives, has strongly emphasized this feature of the situation. The interest alone, on some of the amounts for which verdicts have been rendered, would provide efficient protection over hundreds of miles of railway line.

From the long-time point of view, the argument is even stronger, since forest fires will inevitably result in a future decrease of freight

*The Railway Belt comprises a strip of land extending 20 miles on each side of the main line of the Canadian Pacific railway in British Columbia.

and passenger traffic, as well as in raising the price of ties and other wood products which the railway companies must purchase for their own use. A perfect example of the latter point is furnished by the railway lines running through western Ontario, where, as a result of repeated forest fires, even tie timber has become so scarce that large supplies must be brought in from great distances, at a very great added cost per year. The more progressive of the railway officials themselves are rapidly coming to a full realization of this situation, so that on the whole a very satisfactory desire to co-operate was found to exist on the part of most of the men with whom conferences were held.

In determining the measures to be taken, the prevention of fires was the great consideration, but provision was also required for the control of such fires as might get started. It was recognized that while locomotives form the chief source of fire danger along railway lines, they are by no means the only source, since fires are undoubtedly started by people travelling on foot along the right-of-way, as well as by lighted cigars and cigarettes thrown from trains.

Patrols. — Under regulations 11 and 12, special patrols were required in forest sections wherever the fire danger was sufficiently great to demand such action. Under ordinary conditions of grade and traffic, each patrolman was required to be equipped with a velocipede (hand-speeder). Where the fire danger was great, each man was required to make two round trips per day over his beat, which consisted of from 6 to 15 miles of track, according to conditions. Where one round trip per day would suffice, the length of the patrol district was extended correspondingly. On the heaviest grades only foot-patrols were practicable, these covering from 5 to 10 miles of track each. Where the train traffic was light, as on some of the lines in Southern British Columbia, and elsewhere, it was found practicable to prescribe patrols by power speeder. In this case the patrol district varied from 20 to 50 miles, according to conditions. Power speeders are, however, not practicable for patrol where there is much train traffic, on account of the danger to the patrolman. So far as practicable, track-walkers and bridge and tunnel watchmen were utilized on special patrol work, thus materially decreasing the cost to the railway company.

On portions of the line where the fire danger did not require the establishment of a separate force of special patrolmen, the section-men, track-walkers, and bridge and tunnel watchmen were charged with fire protection as a part of their regular work. In some cases two round trips per day over the line were required, and in others only one. The efficiency of this patrol, as also of the other classes, was greatly strength-

ened through the requirement, in regulation 14, that all regular employees of the company, either on train or track work, be charged with the duty of reporting and extinguishing any fires found burning within 300 feet of the track.

On those portions of the Great Northern and Canadian Pacific systems where the use of crude oil as locomotive fuel was in exclusive effect, a special patrol force was not required, the matter of fire-protection being left to the section men and other regular employees of the companies. The use of oil as fuel was in effect on the Great Northern, on its Cascade Division in British Columbia, from Vancouver to Blaine and to Sumas and Port Guichon, a total of 115 miles. On the main line of the Canadian Pacific in British Columbia, oil-burners were installed during the summer between Kamloops and Revelstoke, including branches, and on about half the locomotives between Revelstoke and Field,—a total distance, with branches, of approximately 338 miles. Oil-burners have also been installed on the 134 miles of the Esquimalt & Nanaimo railway, on Vancouver island. The use of oil has eliminated the greater portion of the railway fire danger on those portions of the lines.

In order to provide an efficient administration, and at the same time handle the work at a minimum of cost to the companies, each local officer of the Board was given authority to modify the requirements of the Chief Fire Inspector, to fit the local requirements of the time and place. Especial care was enjoined in relieving the companies of the necessity for special patrol when conditions were safe. As a result of the very wet season it was possible to very greatly decrease in this way the requirements which it had seemed earlier in the season would be necessary. The placing of full authority in the hands of competent local representatives is distinctly to the advantage of the railway companies, since in this way requirements are made to conform closely to local needs, so that only such measures need be taken as are essential to efficient protection. This proceedure is also to the best advantage of the public, since provision is made for quickly increasing the intensity of protective measures whenever fire conditions are unusually serious.

Letters specifying patrols were written the Canadian Pacific (Western Lines), Canadian Northern, Grand Trunk Pacific, Great Northern, Esquimalt and Nanaimo, and Victoria and Sidney Railway companies.

In order to show fully the general features of the policy adopted, the following draft of letter is quoted in full. This draft was prepared after full conference with the railway officials, for transmittal to the Canadian Pacific railway (Western Lines) to cover fire patrol requirements on that railway west of Fort William during the ensuing

OLD BURN, NOT RESTOCKING, ADJACENT TO RAILWAY TRACK NEAR KITCHENER, B.C.
Burned to mineral soil. Practically no reproduction.

season of 1913. The plans in effect during 1912 were substantially similar, but were in some cases covered in several letters, supplementing each other. The draft is as follows :

THE CANADIAN PACIFIC RAILWAY,

MR. GRANT HALL, *General Manager*,

Winnipeg, Manitoba.

DEAR SIR,—

You are hereby notified that in accordance with the provisions of Order 16570 of the Board of Railway Commissioners you are required to establish upon such portions of the Canadian Pacific railway and of the lines under its control as are hereinafter described, a force of fire-rangers fit and sufficient for efficient patrol and fire fighting duty during the period from April 1st, 1913, to November 1st, 1913, except in so far as you may be relieved in writing from such patrol by the Chief Fire Inspector or other authorized officer of the Board.

Patrols.—The details of the patrols required are as follows, it being understood that unless otherwise specified the patrol shall be continuous between the hours of seven in the morning and six in the evening of each day, including Sundays, with a minimum patrol so far as possible of two round trips per day, one in the forenoon and one in the afternoon.

MANITOBA DIVISION

On the Fort William Ignace and Kenora Subdivisions, between Fort William and Whitemouth, 365.5 miles ; on the Arborg Subdivision, between Toulon and Arborg, 36.7 miles ; and on the Lac du Bonnet Subdivision, between Molson and Lac du Bonnet, 21.5 miles, the patrol shall be a regular part of the work of the section men, who shall be especially instructed with regard to fire work ; minimum patrol of one round trip per day, including Sundays. On the Lac Du Bonnet Subdivision, particular care shall be exercised, after the passing of each train in the day time. On portions of the above lines where no trains are operated on Sundays, special Sunday patrol will not be required.

ALBERTA DIVISION

(1) *Laggan Subdivision.*—Seven men with velocipedes, to be distributed as follows :

Between Bow River Bridge at mileage 53.2 and Canmore, 14.1 miles ;
" Canmore and Bankhead, 12.2 miles ;
" Bankhead and mileage 89, 9.7 miles ;
" Mileage 89 and Castle, 9.7 miles ;
" Castle and mileage 108, 9.3 miles ;
" Mileage 108 and Laggan, 8.6 miles ;
" Laggan and Stephen, 5.9 miles.

These patrols shall be continuous between the hours of seven in the morning and six in the evening of each day, including Sundays, with a minimum patrol so far as possible of two round trips per day, one in the forenoon and one in the afternoon.

Between Stephen and Field, 14 miles, the patrol shall be by one man, who shall work on foot or ride on pushers, as may be most practicable. This patrol shall be supplemented by tunnel watchmen and section crews.

(2) *Crowsnest Subdivision.*—Between Burmis and Hillcrest, 5.4 miles, one foot patrolman who may also be watchman or track-walker.

Between Frank and Sentinel, 9.4 miles, one man with velocipede ; it is suggested that if practicable this man be stationed at Coleman, to facilitate close co-operation with the Divisional Fire Inspector of the Board, who is to be stationed at this point.

Between Sentinel and Crowsnest, 5.3 miles, one foot patrolman, who may also be track-walker.

(3) *Cranbrook Subdivision.*—Between Crowsnest and the Loop tunnel at mileage 5.1, 5.1 miles, one foot patrolman. At the option of the Company, this patrol may be divided between two or more men regularly assigned to track walking, such men to be especially instructed with regard to fire work ;

Between mileage 5.1 and Cranbrook, 93.9 miles, six men with velocipedes, distributed as follows :

Between the Loop tunnel at mileage 5.1 and Wardrop, 15.4 miles ;

Between Wardrop and Fernie, 15.4 miles ;
Between Fernie and Courier, 12.5 miles ;
Between Courier and Jaffray, 18.5 miles ;
Between Jaffray and Tokay, 13.7 miles ;
Between Tokay and Cranbrook, 18.4 miles ;

(4) *Sirdar Subdivision.*—Between Cranbrook and Moyie, 19.8 miles, one man with velocipede ;

Between Moyie and Yahk, 20.9 miles, one man with velocipede ;

Between Yahk and Kitchener, 14.7 miles, one man with velocipede ;

Between Kitchener and McNeillie, 6.5 miles, one foot patrolman who may also inspect track ;

Between McNeillie and Sirdar, 17.9 miles, one man with velocipede.

(5) *Kimberley Subdivision.*—Between Cranbrook and Marysville, Kimberley and the end of the track, 21.2 miles, one man with velocipede ; one round trip per day.

(6) *Waldo Subdivision.*—Between Caithness and the end of the track south of Waldo, approximately 10.7 miles, one man with velocipede, who shall also patrol the spur from branch line to Bains Lake, a distance of approximately 2.5 miles ; to patrol 30 minutes after each train.

(7) *Fort Steele Subdivision.*—Between Colvalli and Fort Steele, 23 miles, one man with velocipede ; to patrol continuously.

(8) *Kingsgate Subdivision.*—Between Yahk and Kingsgate, 10.5 miles, one man with velocipede.

British Columbia Division

District No. 1

On the Mountain Subdivision (between Field and Revelstoke, 130.3 miles), the Shuswap Subdivision (between Revelstoke and Kamloops 129.1 miles), the Okanagan Subdivision (between Sicamous and Okanagan Landing, 50.8 miles), and on the Arrow Lake Subdivision (between Revelstoke and Arrowhead, 27.4 miles), the patrol and fire-fighting work shall be done by the regular force of section men, track-walkers, and watchmen, with a minimum patrol of one round trip per day, including Sundays. No special patrol is required between Chase and Kamloops on the Shuswap Subdivision, and between Mara and Okanagan Landing on the Okanagan Subdivision. The above is based on the assumption that oil will be used exclusively as locomotive fuel during the fire season, and that the right-of-way will be maintained in a condition free from inflammable material, as required by section 297 of the Railway Act. Should either of these conditions not be fulfilled to the satisfaction of the Fire Inspector for the Railway Belt, additional measures will be prescribed by him and may include any of the special measures relating to the above portion of your line enumerated in my letter to the Company dated June 15, 1912. In particular, a special patrol shall be provided by the Company, following 30 minutes after any coal-burning locomotive passing over any portion of district No. 1 in the day time.

Special attention is required on the part of the Company with regard to clearing the right-of-way, since there is a considerable amount of inflammable material along some portions of the line where the danger of fire from sources other than locomotives will necessitate special patrols unless said section 297 is strictly complied with. This matter is under consideration by the Board and will be made the subject of a separate letter at a later date.

District No. 2

(1) *Thompson Subdivision.*—Between Drynoch and North Bend, 42.3 miles, the patrol and fire-fighting work shall be done by the regular force of section men, track-walkers and watchmen ; minimum patrol of two round trips per day, including Sundays.

(2) *Nicola Subdivision.*—Between the water tank at mileage 15 and Nicola, 32 miles, the patrol and fire-fighting work shall be done by the regular force of section men, track-walkers and watchmen ; minimum patrol of two round trips per day, including Sundays.

(3) *Cascade Subdivision.*—Between North Bend and Waleach, 53.4 miles, four men with velocipedes, distributed as follows :

Between North Bend and mileage 14, 14 miles ;
Between mileage 14 and Yale, 13.1 miles ;
Between Yale and Hope, 13 miles ;
Between Hope and Waleach, 13.3 miles.

Should the right-of-way not be cleared to the satisfaction of the Fire Inspector for the Railway Belt, such additional measures shall be taken as shall be prescribed by such Fire Inspector.

Whenever oil shall be used exclusively as locomotive fuel on any portion of the above lines, and satisfactory compliance with Section 297 of the Railway Act shall have been secured, relief will be granted in whole or in part from the above special requirements, upon application to the Fire Inspector for the Railway Belt.

District No. 3

(1) *Proctor Subdivision.*—Between Nelson and Proctor, 20.4 miles, the patrol and fire-fighting work shall be done by the regular force of section men, track-walkers and watchmen; minimum patrol of one round trip per day. An additional patrol shall be made, following 30 minutes after each train running from Nelson to Proctor in the day time.

(2) *Lardo Subdivision.*—Between Lardo and Gerrard, 33.2 miles, one man with velocipede, to patrol 30 minutes after each train.

(3) *Boundary Subdivision.*—Between Nelson and Castlegar, 25.7 miles, the patrol and fire-fighting work shall be done by the regular force of section men, track-walkers, and watchmen; minimum patrol of one round trip per day.

Between Castlegar and Shields, 13.3 miles, one man with velocipede;

Between Shields and Mile Point 41.8, 2.8 miles, one foot patrolman, who may also be bridge watchman;

Between Mile Point 41.8 and Mile Point 50, 8.2 miles, one foot patrolman;

Between Mile Point 50 and Mile Point 55, 5 miles, one man with velocipede, who may also be bridge watchman;

Between Mile Point 55 and Paulson, 7.4 miles, one foot patrolman;

Between Paulson and Coryell, 4 miles, one man with velocipede, who may also be bridge watchman;

Between Coryell and Mile Point 74, 7.6 miles, one foot patrolman;

Between Mile Point 74 and Cascade, 7.9 miles, one foot patrolman;

Between Cascade and Mile Point 92.3, 10.4 miles, one man with velocipede;

Between Mile Point 92.3 and Grand Forks, 2.5 miles, one foot patrolman, who may also be bridge watchman;

Between Grand Forks and Fisherman, 5.6 miles, one man with velocipede, who may also be bridge watchman;

Between Fisherman and Eholt, 8.4 miles, one foot patrolman;

Between Eholt and Greenwood, 8.5 miles, one man with velocipede;

Between Greenwood and Midway, 9.3 miles, one man with velocipede ;

Between Greenwood and Mother Lode Mine, 6.3 miles, one foot patrolman, who may also be bridge watchman ;

Between East Granby and Granby Smelter, 2.2 miles, one foot patrolman, who may also be bridge watchman.

(4) *Slocan Subdivision.*—Between South Slocan and Slocan City, 31.3 miles, one man with velocipede, to patrol 30 minutes after each train.

(5) *Phœnix Subdivision.*—Between Eholt and Athelston, 5.5 miles, and between Coltern and B.C. Mines, 2.5 miles, total 8 miles, one foot patrolman.

Between Reffek and Athelston, 3.1 miles, and between Athelston and Phœnix, 4.2 miles, total 7.3 miles, one foot patrolman.

(6) *Rossland and Trail Subdivisions.*—Between Castlegar and Rossland, 29.3 miles, and between Smelter junction and Trail, 1.4 miles, total 30.7 miles, one man with velocipede to patrol continuously, following 30 minutes after each through passenger and freight train between the hours of 7 in the morning and 6 in the evening, and paying, in addition, as much attention as possible to that portion of the line between Smelter junction and Rossland. If necessary to secure efficient protection, this patrol shall be supplemented by two foot patrolmen between Smelter junction and Rossland.

(7) *Nakusp Subdivision.*—Between Nakusp and Sandon 40.7 miles, and between Three Forks and Kaslo, approximately 25 miles, four men with velocipedes, to patrol 30 minutes after each train, and to be distributed as follows :

Between Nakusp and Summit Lake, 12.7 miles ;
" Summit Lake and Roseberry, 15.7 miles ;
" Roseberry and Sandon, 12.3 miles ;
" Three Forks and Kaslo, approximately 25 miles ; patrol to be established on completion of reconstruction. During the reconstruction of this portion of the line, patrol shall be provided by all regular employees assigned to the work.

Lines Under Construction

Kootenay Central

Between Golden and mileage nine south, 9 miles, one man with velocipede, to patrol after each train running over the line in the day time.

Between Fort Steele and the Southern boundary of the Railway Belt, one patrolman on foot or horseback for each ten miles of the line under construction : *Provided*, however, that, if a co-operative agreement shall be entered into between the Company and the Lands Department of the Province of British Columbia, whereby the patrol along this portion of the line is to be handled by said Department of Lands, such arrangement shall be considered a satisfactory substitute for the special patrols above enumerated.

Alberta Central

Special attention should be given the construction and maintenance of fire-guards, in connection with construction work between Red Deer and Rocky Mountain House, wherever the plowing of fire-guards is practicable. Should special patrols be considered necessary on any portion of this line, such patrols shall be prescribed by Mr. E. H. Finlayson, Fire Inspector.

INSPECTION

For the efficient inspection of and general supervision over the work of the Company under Order 16570, with special reference to the patrols above specified, the following superior field officers have been appointed by the Board, with jurisdiction as indicated :

E. J. Zavitz, Provincial Fire Inspector, Lands Department, Toronto, Ontario : Manitoba Division lines in Ontario.

E. H. Finlayson, Fire Inspector, care Forestry Branch, Customs Building, Winnipeg, Man. : Lines in the Manitoba Division west of Ontario boundary ; Alberta Central west from Rde Deer to the boundary of the Rocky Mountains Forest Reserve. Mr. Finlayson will be assisted by Thomas McNaughton, Divisional Fire Inspector.

P. C. Barnard-Hervey, Fire Inspector for Dominion Parks, care Parks Branch, Edmonton, Alberta : Lines in Laggan Subdivision of Alberta Division between Bow River Bridge at mileage 53.2 and Field, and in the Mountain Subdivision, District No. 1 of British Columbia Division, between Field and Leanchoil.

W. N. Millar, Fire Inspector for Dominion Forest Reserves in Alberta, care Dominion Forestry Branch, Calgary, Alberta : Lines in Crowsnest Subdivision of Alberta Division between Burmis and Crowsnest.

D. Roy Cameron, Fire Inspector for the Railway Belt, care Forestry Branch, Kamloops, B. C.: Lines in Districts Nos. 1 and 2 of the British Columbia Division west of Leanchoil ; Kootenay Central from Golden south to boundary of Railway Belt.

H. R. MacMillan, Provincial Fire Inspector, care Forest Branch, Lands Department, Victoria, B. C. : All lines in British Columbia with the exception of those above indicated as being under the jurisdiction of Messrs. Barnard-Hervey and Cameron. Mr. MacMillan will be assisted by R. E. Benedict, Assistant Provincial Fire Inspector.

A number of other officials of the Dominion and Provincial Governments have been or will be appointed officers of the Board and will assist the above-named superior field officers in carrying on this work. The superior field officer in each case will notify the Superintendent of your Company of the name, title and jurisdiction of the subordinate field officer or officers responsible for the inspection of fire work in his district.

H. C. Johnson has been appointed a Fire Inspector on the Board's staff, with headquarters at Ottawa, and has full authority to act as an officer of the Board in connection with any phase of fire work covered in Order 16570.

General Provisions

So far as practicable, the work of patrol has been combined with the other regular duties of your employees, but where this action has not been specifically indicated the patrol force is to be a specially organized and specially supervised body of men, who shall perform, to the exclusion of other duties, the patrol and other fire-protective work indicated in the Regulations of the Board and specified herein.

In every case where special or section patrols are required, special instructions must be issued and special supervision must be provided by the Company.

As a matter of record, velocipede patrolmen passing telegraph stations shall be reported the same as passing trains and such records shall be freely open to the inspection of any authorized officer of the Board.

Each foot patrolman shall be equipped with one shovel and one canvas bucket. Each velocipede patrolman shall be equipped with two shovels, two canvas buckets and one axe. In addition to the above, and to the regular section equipment, there shall be stored at the tool house for each section in each patrol district the following emergency fire-fighting equipment : one axe, three mattocks and four buckets of not less than twelve quarts capacity each. Equipment for the transportation of patrolmen will also be furnished by the Company as indicated.

The object sought to be obtained by the regulations of the Board and by the instructions issued under them, is the prevention of railway fires. It is desire to avoid as far as possible the imposition of unnecessary expense upon the railway companies, and it is fully realized that the danger of fire will necessarily vary between wide limits during the long season prescribed by the regulations. There is no doubt that a very efficient system of fire control can be established at a minimum of expense if proper provision is made for increasing or decreasing the force as conditions may require or permit. To this end, an average patrol force has been prescribed, with which to begin work, and the various Fire Inspectors appointed by the Board have authority to waive the requirements wholly or in part, from time to time, as may be practicable, it being understood that the roadmaster will restore such patrol upon request of the Board's representative.

In order to make the system properly effective, it is essential that your general superintendents be authorized and directed to furnish additional men for patrol work from time to time, as requested by the superior field officer of the Board having jurisdiction.

It is essential also that the necessity be impressed upon your employees of complying in the utmost good faith with the provisions of Regulation 14 of Order 16570. In particular, section men shall be instructed that they must give the same attention to fire that they do to the safety of the track. On this basis, it is believed that damage by railway fires can be very greatly reduced in the future, at a minimum of cost to the Company.

Please acknowledge the receipt of this letter.

Yours very truly,

Clyde Leavitt,
Chief Fire Inspector, B. R. C.

Instructions to Railway Employees

To cover the issuance of instructions to railway employees under Reg. 14 of Order 16570, the following draft was prepared and approved by the Board. This draft was based upon the form of instructions issued by the Great Northern and Grand Trunk Pacific railways. The form is purely suggestive and was prepared by the Board merely as a basis for the preparation of instructions to suit the needs of each particular railway line. The instructions issued by the various railways are as a rule somewhat different, though in a number of cases the draft prepared by the Board is being followed closely.

Working Instructions in Connection with Order No. 16570 of the Board of Railway Commissioners for Canada, Dated May 22, 1912

To Enginemen, Conductors, Brakemen, and Firemen :

It shall be the duty of train and engine crews on freight and passenger trains, when discovering a fire, on, or adjoining the right-of-way of the Railway Company, to stop and use every effort to extinguish such fire. In the event of this being impracticable, either by reason of the extent of the fire or its distance from the right-of-way, the train shall proceed to the first telegraph station, where the Conductor shall wire a report to the Superintendent, giving the exact location of the fire, and the action taken by engine and train crew concerning the same. It shall also be the duty of Enginemen to stop and notify the first section gang passed, regarding any fire not extinguished as above.

No employee shall do or cause damage or injury to any of the fire-protective applicances on any engine ; open the back dampers of any engine while running ahead, or the front dampers while running tender first, or permit fire, live coals, or ashes to be deposited on tracks or rights-of-way outside of yard limits, unless the same are extinguished immediately thereafter.

To Agents :

Enginemen and conductors of all trains have received instructions to report fire along the right-of-way and adjacent thereto, and it shall be your duty to notify the local fire Inspector of the Railway Commission immediately, giving the exact location of the fire and its extent, and forthwith wire the Superintendent, giving the location of the fire, the extent of the same, and any other information which may be of value, particularly as to the number of men needed to extinguish the fire.

To Roadmasters, Assistant Roadmasters, Master Carpenters, and Other Officials :

In cases where fires are reported, it shall be the duty of any division official to proceed to the scene of the fire as quickly as possible and to take charge of the work of fire fighting until he can be relieved by the Division Roadmaster. The man first on the

ground should organize his men to do the best work possible ; and, when this is done, he should immediately proceed to investigate the orgin of the fire, and fix the location where it started ; get statements from all witnesses, and make every effort to learn the origin and fix the responsibility. The law, as now interpreted, practically makes this Company responsible for fires starting within three hundred feet of the track, unless it can be shown that the Company is not responsible. It is necessary, therefore, to determine positively the origin, in order to relieve the Railway Company of the responsibility. The first officer on the ground should endeavor to hold a joint investigation with the local Fire Inspector of the Railway Commission, or other local forestry officer, and agree upon the origin of the fire. This will avoid disputes later on.

To Chief Dispatchers :

In all cases where fires are reported, it will be the duty of the Dispatcher to get full information as to the extent of such fire, its location, and the number of men necessary to fight it. It will also be the duty of the Dispatcher to furnish whatever train service may be required to move extra gangs, section gangs, or bridge crews, to the fire immediately, giving this movement preference if the emergency requires it.

To Sectionmen, Extra Gangs, and Bridge Foremen :

In all cases where fire occurs, it shall be the duty of all section crews, extra gangs, and bridge crews to proceed immediately to such fires, and extinguish same, remaining as long as may be necessary to do this ; and it must be understood that this is the most important work that can be done, and that the carrying on of your work, though it may be important, must be set aside until the fire is extinguished. The Section Foreman on whose section the fire occurs, shall, in the absence of an official of the Company, make a thorough investigation regarding the origin of the fire, and submit a full report to the Roadmaster.

Between April 1st and November 1st, no ties, cuttings, debris, or litter upon or near the right-of-way shall be burned, except under such supervision as will prevent such fire from spreading beyond the strip being cleared. Officers of the Railway Commission may require that no such burning be done along specified portions of the line, except with the written permission or under the direction of such officer.

Reg. 17, Order 16570—Penalty :

"If any employee or other person included in the said regulations, fails or neglects to obey the same, or any of them, he shall, in addition to any other liability which he may have incurred, be subject to a penalty of twenty-five dollars for every such offence."

Clearing Rights-of-Way

Much was accomplished during the season in securing a better compliance with the requirement of Section 297 of the Railway Act, requiring rights-of-way to be kept free from inflammable material. The

undoubted scarcity of labor has made it difficult in some cases to secure prompt compliance with this requirement. Excellent results have also been secured through the regulation of the burning of inflammable material along rights-of-way, under Regulation 10. The best example of this was in connection with right-of-way burning along the Grand Trunk Pacific construction in British Columbia. Much damage to timber was being done by fires escaping from right-of-way clearings in early July, and, upon the recommendation of the British Columbia Forest Branch, the Board authorized instructions prohibiting further burning until the fall rains should render such burning safe.

Situation in the East

After the work was organized in the west, it was too late to organize in the east for the small remaining portion of the fire season of 1912. The matter of co-operation has, however, been taken up by the Board with the Governments of the Provinces of Ontario, Quebec, New Brunswick and Nova Scotia. In some cases the plan of co-operation has been confirmed promptly by the provincial government, while in others action has been more slow, especially with regard to the designation of the official to be appointed provincial fire inspector. However, it is believed that the organization will ultimately be completed, and that the patrol provisions of the Order will be extended to cover the entire Dominion during the fire season of 1913.

Inspection

A co-operative arrangement was entered into with the Forest Branch, Lands Department of British Columbia, and with the Dominion Forestry and Parks Branches, Department of the Interior, in order to provide a system of inspection for the enforcement of the instructions of the Chief Fire Inspector and of the provisions of Regulation 10 (concerning the burning of inflammable material along rights-of-way), Regulation 14, (reporting and extinguishing of fires by regular employees of railway companies), and of Section 297 of the Railway Act (clearing of rights-of-way). Under this arrangement, a number of the officials of each of these organizations were appointed officers of the Board, without additional compensation. The supervision of this work was handled by the superior field officers of each organization in addition to their other duties; but, so far as practicable, arrangements were made to have the detailed field inspections handled by men who should devote their whole time to this work, thus insuring continuous attention and the most efficient results.

The inspection work handled by the British Columbia Forest Branch embraces lines in British Columbia, except the Railway Belt. To supervise this work, H. R. MacMillan, Chief Forester, was appoint-

GANG CLEARING RIGHT-OF-WAY
As required by Sec. 297 of the Railway Act. Southern British Columbia.

GRAND TRUNK PACIFIC RIGHT-OF-WAY
114 miles east of Prince Rupert, B.C.

ed Provincial Fire Inspector, and R. E. Benedict, Assistant Forester, was appointed Assistant Provincial Fire Inspector, headquarters, Victoria. To handle the details of actual field inspection, the following were appointed Divisional Fire Inspectors : W. F. Loveland, T. S. Palmer, and W. H. Smith: lines south of the Railway Belt, including Canadian Pacific, Great Northern, Kettle Valley and Morrissey, Fernie and Michel railways ; headquarters, Nelson.

Fred D. Markland, lines on Vancouver Island :—Esquimalt & Nanaimo ; and Victoria and Sidney railways ; headquarters, Victoria.

J. K. McLean, east section of Grand Trunk Pacific ; headquarters, Tete Jaune Cache.

R. M. Pellatt, middle section of Grand Trunk Pacific ; headquarters, Fort George.

Geo. A. Kerr, west section of Grand Trunk Pacific, headquarters, Prince Rupert.

In the Dominion Forestry Branch, Department of the Interior, the following appointments were made :

D. Roy Cameron, District Inspector of Forest Reserves, Kamloops, B.C., appointed Fire Inspector for the Railway Belt, exclusive of Dominion Parks. This includes the main line of the Canadian Pacific railway through British Columbia, and tributary branches within the Railway Belt. Mr. Cameron was assisted by two divisional fire inspectors, W. R. Peacock, and J. B. McKenzie. R. D. McDonald later succeeded Mr. McKenzie on this work.

W. N. Millar, District Inspector of Forest Reserves, Calgary, Alta., appointed Fire Inspector for Dominion Forest Reserves in Alberta. This includes those portions of the Canadian Pacific and Canadian Northern lines within forest reserves on the east slope of the Rockies. Mr. Millar was assisted by the Forest Supervisors under his jurisdiction.

E. H. Finlayson, Inspector of Fire Ranging, Winnipeg, Man., appointed Fire Inspector ; to handle inspection work in the forested portions of Manitoba and Saskatchewan, and in Alberta outside Dominion Forest Reserves and Parks. This includes portions of the Canadian Pacific railway, Canadian Northern railway, and Grand Trunk Pacific railway.

In the Dominion Parks Branch, Department of the Interior, Howard Douglas, Chief Superintendent, Dominion Parks, Edmonton, Alta., was appointed Fire Inspector for Dominion Parks. Mr. Douglas was assisted by F. E. Maunders, Superintendent of Yoho Park, Field, B.C., and by A. B. MacDonald, Superintendent Rocky Mountains

Park, Banff, Alta., as to that portion of the Canadian Pacific railway affected ; and by Byron Burton, Superintendent of Jasper Park, Fitzhugh, Alta., as to the portions of the Canadian Northern railway, and Grand Trunk Pacific railway within the Park boundaries. All three were appointed Divisional Fire Inspectors. P. C. Barnard-Hervey later succeeded Mr. Douglas as Chief Superintendent of Dominion Parks and therefore as an officer of the Board.

The field inspectors on the staff of the Board, in the Operating and Engineering Departments, have rendered material assistance in supplementing the fire inspection work performed by the above organization. This has been especially true with regard to clearing of rights-of-way and the construction of fire-guards.

In order to show fully the lines of policy adopted in connection with handling the field inspection, the following draft of Memorandum of Instructions is quoted. This draft was prepared for issuance during the early spring of 1913, and is substantially the same as the Memorandum of Instructions issued during 1912.

Memorandum for the information of Dominion and Provincial Officials Appointed Officers of the Board of Railway Commissioners, for the Enforcement of Order No. 16570 of the Board.

Each Fire Inspector appointed by the Board should be supplied with copies of Order No. 16570 ; Extracts from the Railway Act ; this memorandum ; letter of the Chief Fire Inspector to the Railway Company, prescribing fire-protective measures, or such portions of said letter as may be necessary to familiarize the Inspector with the obligations placed upon the Company within the territory to which he is assigned ; Employees' time-table covering lines to which Inspector is assigned,—these to be secured from the Railway Company ; instructions by the Railway Company to its employees, in accordance with Regulation 15 ; such additional instructions as may be given to the Fire Inspector by his superior officer.

The object of the plan of co-operation, in effect with the Dominion and Provincial authorities, is the prevention and control of railway fires, through the enforcement of Order 16570. To this end, it is expected that the fire-protective work of the Companies will be carefully and constantly checked at all points, as indicated in the various requirements above enumerated.

Each superior field officer should get in touch with the local Railway Superintendent, and should notify him in writing, in advance of the fire season, of the name, title, address, and jurisdiction of each subordinate field officer of the Board, who will handle fire inspection work within the railway district in question. The Superintendent should likewise be informed of any changes in personnel affecting railway fire inspection in his district.

Each Divisional Fire Inspector should have some definite station, at which he can always be notified by railway officials of fires occurring within his jurisdiction. The railway officials concerned should be notified of this address. Arrangements should be made at the official station for the prompt forwarding of messages to the Inspector, wherever he may chance to be in his district.

The attitude of the Inspector should be so far as possible, one of co-operation with the Company, rather than of criticism. The direct decrease in fire losses and damage claims should render the fire-protective work a paying investment on the part of the Companies, assuming that no unreasonable requirements are made of them.

Probably, in most cases, difficulties can be readily adjusted directly between the local Fire Inspector and the local representative of the Company. However, where this is impracticable, the matter should at once be reported to the superior field officer, who will communicate with the appropriate higher officials of the Company, usually the General Superintendent. If the difficulty cannot be satisfactorily adjusted in this way, a report should at once be forwarded to the Chief Fire Inspector, by wire, collect, or by mail, as may be appropriate under the circumstances. In each case a definite recommendation should be included in the statement, covering the action desired. Where reports are forwarded by mail, a statement should also be included as to the extent to which the matter has been taken up with the railway officials, and their attitude in the case.

The Inspector in charge of each portion of the organization should consider himself responsible for securing protection from fire within the territory to which he is assigned. In every case, the plan of protection provided in the letter of the Chief Fire Inspector to a railway company is subject to any needed change by authorized field officers of the Board, and each Inspector should without hesitation initiate any action necessary to make the plan fit the conditions as they may exist from time to time. In accordance with the Regulations and the instructions issued to the Companies by the Chief Fire Inspector, relief, either temporary or permanent, according to circumstances, should be granted the Company from any requirements which are unnecessary. The constant aim should be to secure efficient protection from fire at a minimum of cost to the Company. So far as possible, the administration should be in the field, and matters should be fully taken up direct with railway officials. The Chief Fire Inspector should be informed of modifications made in fire plans when the regular periodical reports are submitted to Ottawa, at least once each month.

Each fire occurring along or near the right-of-way should be carefully investigated, and a report should be submitted to the superior field officer, covering the cause of the fire, its extent, and the class, amount, and value of property destroyed. Particular care should also be taken to secure a check with regard to the

number of incipient fires extinguished, since this is an indication, not only of the efficiency of the patrol, but of the necessity of its continuation and of the intensity necessary.

During the season of 1913, particular care should be taken to report separately every authentic case of a fire set by sparks from a coal-burning locomotive. Positive information should be secured wherever possible. The object is to determine, so far as practicable, the extent to which fires are caused by sparks from locomotives, and general assumptions will be of little or no value for this specific purpose. In each case where it is positively known that a locomotive has set a fire, the record of inspections at the terminal should be consulted, to determine the condition of the netting mesh; and this point should be included in the report to the Chief Fire Inspector.

In sections where oil fuel is in use, every effort should be made to determine whether and under what circumstances fire is caused by the operation of such locomotives. A complete report should be submitted to the Chief Fire Inspector in each case.

A statistical report to the Board will be expected at the end of the fire season, with regard to fire damage along railways within the territory under the jurisdiction of each superior field officer of the Board.

In addition to the above, each superior field officer is requested to submit to the Chief Fire Inspector at some convenient time, or times, during each month of the fire season, a brief statement of the railway-fire situation within the territory under his jurisdiction, as an officer of the Board. This need not be a detailed report, but should cover briefly the general features of the situation, with particular reference to the compliance of the companies with the requirements made of them, the general efficiency of such measures, the general weather conditions, and a general statement as to the amount of railway-fire damage since the last report. This action is essential in order that the Board may maintain proper touch with the field situation. To some extent, this action may, if preferred, be taken by forwarding carbon copies of weekly or monthly reports, submitted by Divisional Fire Inspectors.

Where correspondence is being carried on in the field, with regard to matters of which the Ottawa office should be informed, the necessity of writing additional letters to the Chief Fire Inspector may frequently be obviated by mailing carbon copies, without letters of transmittal. This is especially important where modifications are made in the requirements imposed by the Chief Fire Inspector. Where essential to a proper understanding of the situation, copies of letters from the railway officials concerned should also be forwarded, but in many cases this may not be necessary.

When Fire Inspectors, for whom transportation has been secured by the Board, are laid off before the close of the calendar year, unexpired passes should be returned to the Chief Fire Inspector for cancellation.

By direction of the Board, all telegrams in answer to messages from a railway company, or telegrams the immediate effect of which would prove beneficial, or of special interest to the Company, should be sent collect. Where we want information or want a railway company to take some action which they would not be likely to take of their own initiative, the message should be paid for. In case a message sent collect in accordance with the above, is refused by a railway official, the charge necessary for delivery should be paid by the sender, and the matter should immediately be reported to the Chief Fire Inspector by mail.

The Board of Railway Commissioners can pay no accounts for fire-fighting work. This is a matter which must be handled between the Railway Companies on the one hand, and the Dominion or Provincial authorities on the other, according to the regulations of the Board and existing Dominion or Provincial legislation. In cases where co-operative agreements can be made between the Companies and the Dominion or Provincial Department concerned, this will simplify the matter very materially. It is assumed that the first effort will, in any event, be to extinguish the fire immediately, leaving the question of re-imbursement for the cost to be settled later. It is also assumed that, in case of a fire for which the Railway Company is presumably responsible, the railway official will be in charge ; and the local officer of the Board will assist so far as possible, but will not take charge, unless so requested by the railway representative.

A careful check should be made in case of every fire to determine definitely whether trainmen and agents have complied with the requirements of Regulation 14, with regard to notifying railway employees and forest officers of fires occurring along rights-of-way. Each case of infraction should be reported to the higher officials of the Company, in order to secure complete observance of the Order, in case of future fires.

The condition of the right-of-way should be reported on at the end of each season, but a special report should be submitted whenever immediate attention is needed with regard to any particular portion of the line. Successive reports should then be submitted at short intervals on the progress of the work, in order that the matter may be further taken up with the Company if necessary.

Infractions of Regulations 6, 7, and 8, when observed, should be reported to the Chief Fire Inspector, and the matter should, at the same time, be taken up direct with the General Superintendent of the railway company concerned.

The inspection of fire-protective appliances on locomotives will be handled in general by the Inspectors, stationed at Calgary, Winnipeg, Toronto, and Montreal, appointed for this work, under the Operating Department of the Board. Fire Inspectors are requested to co-operate as fully as possible with the Operating Department in this connection, by promptly notifying the nearest

office of the number or other description of any locomotive which is throwing sparks to a greater extent than the average or which is known to have set a fire. Letters or telegrams should be addressed : Inspector, Operating Department, Railway Commission, Calgary ; Winnipeg ; Postal Station F, Toronto ; or 850 Grey Avenue, Montreal, as the case may be. At the same time, a telegram should be also sent to the General Superintendent within whose jurisdiction the locomotive is operating, and a copy should be mailed to the Chief Fire Inspector.

It has been found that, in general, the inspection of fire-protective appliances by the railway companies themselves results in the early discovery and rectification of defects. The check inspection by the Companies, required in Regulation 4 (*d*), supplemented by the inspection by the Operating Department of the Board, renders it unnecessary, in general, for the officers of the Fire Inspection Department to co-operate further than as above indicated.

The utmost freedom of suggestion by field officers is invited, with regard to any features of the work under Order 10570.

CLYDE LEAVITT,

Chief Fire Inspector, B.R.C.

Results of Fire Patrols, Season 1912

As previously noted, Order 16570 was issued May 22, 1912. On account of the time required for organizing the work, holding the necessary conferences with railway officials, and enabling the railway companies to organize by securing necessary equipment and personnel, it was not possible to get the prescribed special patrols actually in effect before the months of July and August. The very unusually wet season then rendered unnecessary the establishment of a considerable number of the patrols prescribed. Many of the patrols, were, however, established as prescribed, and did excellent service.

Principally on account of the weather conditions, the only serious railway fires occurred during the early part of the summer, before the measures required by Order 16570 could be put into effect. Statistics of railway fire damage are necessarily incomplete. The accompanying table has been prepared from the somewhat fragmentary data available.

SUMMARY OF REPORTS ON FIRES OCCURRING ADJACENT TO RAILWAY LINES SUBJECT TO THE JURISDICTION OF THE BOARD OF RAILWAY COMMISSIONERS FOR CANADA IN BRITISH COLUMBIA, ALBERTA, SASKATCHEWAN, AND MANITOBA. SEASON OF 1912. (EXCLUSIVE OF PRAIRIE FIRES.)

	Canadian Pacific	Canadian Northern (*)	Grand Trunk Pacific	Great Northern	Esquimalt and Nanaimo	Victoria and Sidney	Totals
Number of fires reported as starting within 300 feet of track (†)	80	71	42	3	2	2	200
Causes of fires :							
(a) Trains	67	62	28	3	2	2	164
(b) Tramps, etc., and camp fires	4	4	4	....	....	....	12
(c) Other known causes	5	5	10	....	....	....	20
(d) Unknown	4	.....	.....	....	....	....	4
Acres burned over by fires outside right of way :							
(a) Grass or cultivated land	35	3500	600	....	....	....	4135
(b) Young forest growth	16070	.....	945	2	....	....	17017
(c) Timber land	1010	7	205	100	....	....	1322
(d) Slashing or old burn not re-stocking	510	1004	120	900	....	140	2674
(e) Total	17625	4511	1870	1002	....	140	25148
Value of property destroyed :							
(a) Young growth	$51,150	.....	$ 500	$ 5	....	....	$51,655
(b) Standing timber	12,250	2,500	1,825	600	....	....	17,175
(c) Forest products in process of manufacture	50	.....	500	....	$100	....	650
(d) Railway property not covered in above	.....	.....	18,250	....	....	....	18,250
(e) Other private property not covered in above	100	150	500	....	....	....	750
(f) Total	$63,550	$2,650	$21,575	$605	$100	....	$88,480

(*) Does not include lines in British Columbia—Canadian Northern Pacific, not subject to Board.
(†) Many incipient fires not reported.

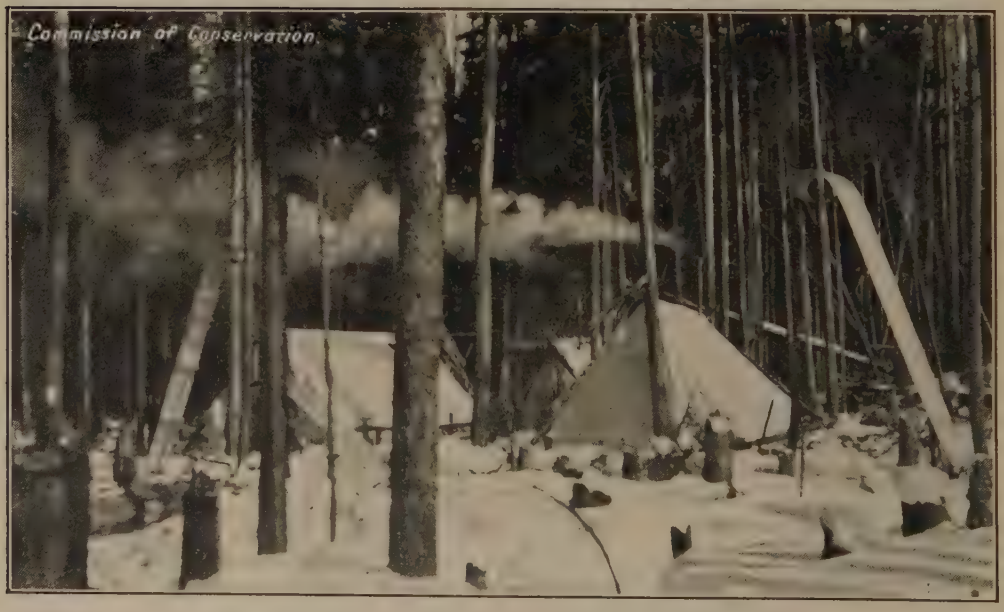
Fire-Guards

Owing to lack of time, it was not possible to make a detailed study of the fire-guard question in advance of the issuance of instructions for the summer of 1912. The policy previously adopted was therefore continued ; this entailed a blanket requirement that fire-guards should be constructed along railway lines in the prairie sections, except where satisfactory proof could be made by the company concerned that such construction was either unnecessary or impracticable. Such construction was required, as formerly, in the Provinces of Alberta and Saskatchewan, and, in addition, in Manitoba, where it appeared that protection was needed by the farming interests.

In order to make this situation entirely clear, the following extracts are quoted from the instructions issued the various railway companies concerned :

> "A fire-guard within the meaning of this order shall be understood to be a strip of plowed land not less than sixteen feet in width, along each side of the right-of-way ; the outer edge of each strip to be not less than three hundred feet distant from the centre of the railway, except where, for a good reason to be shown, construction at the distance specified is impracticable. In sections where fire-guards are necessary, and on account of brush or timber it is impracticable to plow, the fire-guard may be constructed by clearing away the brush or undergrowth and removing all combustible matter on the ground, thoroughly exposing the mineral soil for the required width, in such manner as to form an efficient fire-guard.
>
> "Where a fire-guard has been constructed within two years past, strictly in accordance with the above requirements, discing will be acceptable instead of plowing, but all weeds and other inflammable material must be plowed or disced under the furrow, so as to make a good and efficient fire-guard.
>
> "Where fire-guards have previously been constructed which are not strictly in accordance with the above requirements, new fire-guards must be constructed which will conform to the specifications. However, where fire-guards have already been constructed this season at a distance of less than three hundred feet from the track but are otherwise according to the specifications herein contained, such construction will be accepted for this year's requirements, but no longer.
>
> "The construction of such fire-guards shall be completed as specified, within the said Provinces of Alberta, Saskatchewan and Manitoba, not later than the fifteenth day of August, 1912.
>
> "Between the said fifteenth day of August and the first day of December, the Company shall keep the said fire-guards, and each parcel or section of land between them and the railway, free from dead or dry grass, weeds and other unnecessary combustible matter.

RAILWAY RIGHT-OF-WAY PREVIOUS TO CLEARING
As required by Section 297 of the Railway Act



A WINTER FOREST SURVEY CAMP IN NORTHERN ONTARIO

"Wherever satisfactory arrangements can be made with the owners of cultivated lands who object to the construction of fire-guards through fields of grain, flax, hay, etc., while the crop is on the ground, fire-guards as above specified shall be constructed at the earliest possible date after the removal of the crop, and the stubble shall be then burned over between the fire-guard and the track.

"Where owners of cultivated lands object to the construction of fire-guards through fields of grain, flax, hay, etc., arrangements should be made, wherever possible, for the utilization, during the ensuing year of strips not less than sixteen feet in width, at a distance of not less than three hundred feet from the track, for the growing of root crops, such as potatoes, turnips, beets, etc., since such strips will serve as efficient fire-guards and will not prevent the utilization of the land, as would be the case were fire-guards plowed through fields of grain, flax, hay, etc., Where efficient protection can be secured in this way, such procedure will be construed as a compliance with the requirements of the Board.

"In all cases where the owner objects to the construction of fire-guards across lands under cultivation at the time when fire-guards are being constructed on adjacent lands, the fire-guard on each side of such cultivated land shall be turned in to the right-of-way and especial care shall be taken to connect the two such ends, either by plowing along the outer edge of the right-of-way, in such a manner that a fire occurring between the track and the fire-guard on either side of such cultivated land, may not spread around the ends of the fire-guard and endanger the land under cultivation, either before or after the removal of the crop.

"The provisions of this Order shall apply to the portions of the line under construction, or to be constructed, in the three Provinces named, the same as to portions under operation. In other words, fire-guards are to be constructed at the time when the grading is done on each new portion of the road."

Fire-Guard Inspection

As previously noted, the field Inspectors of the Operating and Engineering Departments of the Board of Railway Commissioners assisted in the fire-guard inspection. Assistance was also rendered by Mr. E. H. Finlayson, Inspector of Fire Ranging, Forestry Branch, who was appointed Fire Inspector in the Fire Inspection Department, in accordance with the plan of co-operation previously described. Mr. Finlayson's duties were more specifically in connection with the inspection of patrols and the clearing of rights-of-way, but the assistance rendered in connection with the fire-guard work was very valuable.

For the inspection of fire-guards in Alberta, a co-operative arrangement was made with the Department of Agriculture of that Province whereby Mr. Benjamin Lawton, Chief Fire Guardian, was appointed Fire-Guard Inspector for the Board. A similar plan has been approved

by the Government of Saskatchewan, and it is expected that fire-guard inspection in that Province will be largely so handled during the season of 1913. The arrangement was not made in sufficient time to be effective during the season of 1912. In Manitoba, a proposition for a similar plan of co-operation was made, but did not meet with approval, as the Government of that Province felt that the inspection should be handled directly by the Board. Other arrangements will accordingly be made as to fire-guard inspection in Manitoba.

Fire-Guard Study

In order to make the requirements for fire-guard construction in 1913 and thereafter correspond as closely as possible to local conditions and needs, an exhaustive study of the question has been undertaken. Co-operation was arranged with the representative agricultural organizations of the Prairie Provinces, namely the United Farmers of Alberta, the Saskatchewan Grain Growers' Association, and the Manitoba Grain Growers' Association. Through the Secretaries of these Associations, circulars were sent to the secretaries and other representative members of the local organizations throughout the Provinces named, calling for answers to a large number of specific questions. The replies to these questions, with other information available, will form the basis for conferences with representative railway officials, and ultimately for the issuance of instructions as to fire guard construction during 1913 ; these instructions should be very much more satisfactory, especially as to land under cultivation, than were the instructions for 1912. The circular used in this connection follows :—

Fire-Guard Construction in Prairie Provinces

Explanatory Note: The present requirements of the Railway Commission, as to fire-guard construction by railway companies in the prairie provinces, call for a ploughed strip not less than 16 feet in width, on each side of the track, at a distance of not less than 300 feet from the track, except where unnecessary or impracticable. The railway company is also required to burn over the whole 600 foot strip. In order that efficient protection may be secured during 1913, at a medium of cost to the companies and of loss and inconvenience to the farming interests, a full discussion is invited with regard to the following points, on the part of everyone interested. If preferred, this outline may be considered merely as a basis for discussion, and the whole subject treated in letter form on separate paper. In any event, some answers may require more space than is here provided, and if so, the supplemental data should be submitted on separate sheets, using corresponding figures and letters to designate questions and sections of questions being answered.

Return answers to.....

1. Name of railway company or companies and portions of lines (inclusive of stations), to which your answers to the following questions apply.....
.....

2. As to Cultivated Lands

(*a*) In your section, is fire-guarding necessary through cultivated lands, aside from burning over the right-of-way ?.....

(*b*) Do locomotive sparks set fire directly in stubble ?.....

(*c*) Is there any danger of fire previous to harvest ?.....

(*d*) In what crops is fire-guarding not necessary, either before or after harvest ?.....

(*e*) Name crops which require fire-guarding following harvest.....

(*f*) What width of strip should be ploughed ?.....

(*g*) What should be the distance of the outer edge of the ploughed strip from the track ?.....

(*h*) When should the ploughing be done ?.....

(*i*) Should the ploughing be in a solid strip, or in two narrow strips with an open space between?.....

(*j*) Should the burning cover only the right-of-way, or entire area between ploughing and track, or right-of-way and narrow strip between two sections of ploughing ?.....

(*k*) Is it practicable and safe to burn fire-guards through hay meadows without ploughing ?.....

(*l*) To what extent have railway fires occurred in your section in cultivated lands during the past four years ?.....

3. As to Fenced Pasture Lands

(*a*) In your section, is fire-guarding necessary through fenced pasture lands, aside from burning off the right-of-way ?.....

(*b*) If so, what width of strip should be ploughed ?.....

(*c*) What should be the distance of the outer edge of the ploughed strip from the track ?.....

(*d*) When should the ploughing be done ?.....

(*e*) Should the ploughing be in a solid strip, or in two narrow strips with an open space between ?.....

(*f*) Should the burning cover only the right-of-way, or entire area between ploughing and track, or right-of-way and narrow strip between two sections of ploughing ?.....

(*g*) To what extent does discing make an efficient fire-guard the second or successive years after ploughing ?.....

(*h*) To what extent have railway fires occurred in fenced pasture land during the past four years ?.....

4. As to Open Prairie Lands

(*a*) To what extent have grass fires occurred in your section in the open prairie, caused by locomotive sparks, during the past four years ?.....

(*b*) Should the ploughing for fire-guards in the open prairie be in a solid strip, or in two narrow strips with an open space between ?.....

.....

(*c*) Does a 16-foot ploughed strip 300 feet from the track constitute an efficient fire-guard without burning off between the right-of-way and the track ?.....

.....

(*d*) How practicable is it to burn off a 300-foot strip each side of the track in open prairie, assuming strips will be ploughed at the outside limits ?.....

.....

(*e*) If a 300-foot strip is to be burned off on each side of the track, is it necessary to plough as wide a strip as 16 feet at the outer edge on each side, from which to back-fire and to stop later fires within fire-guard on portions imperfectly burned ?.....

.....

(*f*) What width of ploughing is recommended ?.....

(*g*) Will two 8-foot strips of ploughing, with an open space between of 30 feet width, this space to be burned over, constitute a satisfactory fire-guard, without burning over the ground between the ploughing and the right-of-way ?.....

.....

(*h*) Will discing and harrowing make an efficient fire-guard the second or successive years after ploughing, or is reploughing necessary each year ?.....

(*i*) What system of fire-guarding is recommended for open prairie ? .....

.....

.....

.....

---

5. What is the best way to prevent the spread of weeds from fire-guards ? Discuss for open prairie and for pasture lands.....

.....

.....

6. Does a graded wagon road paralleling the track constitute an efficient substitute for the construction of a ploughed fire-guard ?.....
If so, state the greatest and least distances from the track when the presence of such a road should relieve the railway company of the necessity for ploughing guards. Answer for (a) Open prairie, from.....to.....feet ; (b) Fenced pasture, from.....to.....feet ; (c) Cultivated land, from.....to.....feet.

7. In your opinion, to what extent would farmers or other landowners be willing to contract with the railway companies for ploughing fire-guards across their own lands in return for old ties from the track, to be used as fuel assuming that fire guards across cultivated lands should be ploughed immediately following the harvest, and that width of ploughing and distance from track will conform to needs of local conditions ? Discuss as to cultivated lands, fenced pasture and open prairie and fully as to what you think would be a fair arrangement in cases where the necessary work on the farmer's land is done by the farmer.....

.....

.....

.....

8. Where the above arrangement can not be made, to what extent are farmers likely to object to the ploughing of fire-guards by agents of the railway companies ?

.....

9. In what way can the above objections be reasonably met ?.....

.....

10. Where the land owner refuses to allow the railway company access to his lands for the construction of fire-guards, should not the company be relieved of responsibility for damage to the property of such owner through fires occurring because of the absence of fire-guards across his lands ?.....

.....

11. To what extent is it practicable for the farmer to grow some non-combustible crop on a strip along the right of way, such as alfalfa, beets, potatoes, etc., thus forming a perfect fire-guard ?.....

.....

12. What fire protection is necessary along railway lines through poplar (aspen) lands? (Omit if no such lands in your section).....
.....
.....

13. Give any suggestions as to fire-guard situation not covered above .....
.....
.....
.....

Signature.....
Official title (if any).....
.....
Post Office.....
Province.....

Part II

Forest Fires and the Brush Disposal Problem

The slash menace constitutes the greatest single problem in connection with forest fire protection.

Lumbering Slash.—The large areas of inflammable material following old-style lumbering operations are almost certain to catch fire sooner or later. As a matter of fact, most of the serious fires have started in slashings. Control of such fires in dry seasons is almost impossible, and the loss of life and property has been enormous.

In addition to the destruction of merchantable timber on adjacent lands, the second crop on the cut-over lands is, in case of a forest of mixed age-classes, retarded by fire for at least 50 to 100 years, through the destruction of the young growth under merchantable size. This of course does not apply to a forest where the trees are practically all of merchantable size, especially where fire, following cutting, facilitates reproduction, as is true of Douglas fir on the Pacific Coast and of western white pine in the interior.

In many cases, the soil is so injured by fire and resulting erosion, that it is rendered incapable of producing merchantable timber for generations and possibly hundreds of years. Very frequently the composition of the forest is changed as a result of fire on either virgin or cut-over lands. Everyone is familiar with the growth of aspen, birch or jack-pine, which frequently follows fire on cut-over lands in Eastern Canada. The rapid extension of lumbering operations into new sections constantly increases the extent of territory subject to this class of fire menace.

Settlers' Slash.—The slash resulting from clearing operations of settlers is a source of fire danger which ranks closely with the lumbering slash. In one sense, the danger from this source is greater, since the settler's slash must be burned, and there is naturally a strong tendency to perform this operation at a season when a clean burn can be secured. As a result there is a great danger of fire escaping and getting either into virgin forest or into adjacent lumbering slash, frequently causing great loss of property and even of life. Considerable progress has, however, been made, through legislation, in the regulation of settlers' slash-burning operations. The principal point to which further attention in this connection is most urgently needed is the employment through the summer season of a sufficiently large force of efficient rangers to ensure strict compliance with the laws.

THE EFFECTS OF FIRE ON NON-AGRICULTURAL MOUNTAIN LANDS IN SOUTHERN BRITISH COLUMBIA
All such lands should be protected in order that they may add to the wealth of the country by producing successive timber crops.

Methods of Organization.—The solution of the problem of the lumberman's slash has been the subject of a great deal of study both in the United States and Canada. On account of differences in economic conditions the situation at the present time is more advanced in the former than in the latter. As to lands in the United States owned by the Federal Government, the lead has been taken by the United States Forest Service, through the imposition of requirements for brush disposal in connection with sales of timber in the National Forests of the Western States. As to lands in private ownership, which comprise four-fifths of the timber of the country, progress has also been made through the enactment of state legislation, particularly in New York, Minnesota and Oregon, and through voluntary co-operation on the part of the associations of timber-land owners in the Pacific Northwest comprising the Western Forestry and Conservation Association. Up to the present time, this organization is limited to the States of Washington, Oregon, Idaho, Montana and California. In addition to fire patrol, the organizations comprising this Association furnish expert assistance in supervising the disposal of slash, thus ensuring the greatest possible efficiency and safety.

Situation in Canada.—In contrast to the short-sighted policy which so long prevailed in the United States, the Dominion and Provincial Governments of Canada have wisely retained the ownership of non-agricultural lands to a very large extent, disposing for the most part only of the right to cut timber under specified conditions. Thus, the necessity for voluntary action through the formation of lumbermen's associations is not nearly so urgent as in the United States. With the exception of the relatively small percentage of timber land in private ownership, the situation is, in the long run, within the control of the Dominion and Provincial Governments, in connection with the issuance of new licenses and renewals of those previously issued. In some cases, all that is needed is the enforcement of provisions already included within licenses. This is particularly true of those issued by the Dominion Government, where ample provision is made on paper for brush disposal but where these provisions have not been enforced. This continued lack of enforcement has resulted in what is doubtless regarded by many of the licensees as a sort of vested right, which it will no doubt be difficult to overcome.

In Eastern Canada, the stand of timber is not nearly so heavy as on the Pacific slope, and the problem of brush disposal must be handled in a different way. The conditions in the Adirondack region of New York, where much has already been done along this line, are closely similar to those in the spruce region which covers so large an area in eastern Canada. Much may also be learned from the experience in

Minnesota, where conditions are similar to those over a large area of forest country in Ontario and Southeastern Manitoba. In the same way, forest conditions in Alberta and British Columbia are closely similar to those in Montana, Idaho, Washington and Oregon, where the problem of brush disposal has been the subject of a great deal of investigation and discussion. For these reasons, conditions in the regions named are discussed in some detail later in this report.

Brush Disposal Necessary

While patrols, the use of spark arresters, care with camp-fires, and similar measures are, and will continue to be, necessary, the root of the problem so far as the slashing menace is concerned, can best be reached through the adoption of measures for the disposal of debris from woods operations, in sections where the fire danger is extreme. It must be recognized that conditions vary widely, and that measures to be taken must be justified by the intensity of the fire danger, and must also be practicable from a business point of view.

In the past, when stumpage values were low, and the margin of profit small, owing to large supplies and keen competition for the market, intensive methods could not be practised. Now, however, timber values are becoming sufficiently high to justify the owner in spending money to protect his remaining timber from fire, and, to a certain extent, in protecting the young growth for the sake of later cuttings. This is particularly true in the pulpwood sections, where repeated operations are practicable within reasonable limits of time. This consideration, however, should appeal with especial force to the Provincial and Dominion Governments in Canada, which, fortunately, still retain to a very large extent the ownership of immense areas of non-agricultural lands which are suitable only for the production of timber. Governments can best afford to hold lands for forest production, on account of the long time element involved, and thus are particularly interested in maintaining the forest productive capacity of their non-agricultural lands. The question of fire-protection and thus of brush disposal should appeal to Government agencies with especial force.

No Hardship upon Operators.—The imposition of conditions under which cutting will be permitted upon Government lands is in reality no hardship upon operators, since these conditions are taken into consideration in fixing the prices to be paid for the privilege of cutting. This is self-evident as to the issuance of new licenses, where the operator knows the conditions in advance and makes his tender upon that basis, thus throwing upon the Government, where it belongs, the cost of providing for the perpetuation of the forest. In case of renewals of licenses

previously issued, there may be some difference of opinion, but the attitude here should be that stumpage values are constantly increasing, that the Government should get the benefit of a reasonable proportion of this increment, thus necessitating periodical readjustments of the purchase price, and that restrictions upon the method of cutting in order to perpetuate the forest as such, are a part of such price, which must be taken fully into consideration in determining the cash payments.

Disposal of Conifers and Hardwoods.—Brush disposal as a fire-preventive measure is generally considered at the present time only in connection with coniferous or so-called evergreen species,—the spruces, firs, pines, hemlock, etc.—as contrasted with the so-called hardwoods or broad-leaved species, such as the maples, beech, birch, etc. Coniferous species are found almost exclusively in the West. In the Northeastern United States and Eastern Canada the principal species being cut on a large scale are also conifers. The hardwoods rot much more quickly than do the conifers, so that the debris disappears by decay in a much shorter time. Further, the danger of fire in a hardwood slashing is in no way comparable at any time to the danger in a coniferous slashing. It should also be borne in mind that in a hardwood forest, the fire danger is due to the leaf litter rather than to the tops, though the tops may increase the severity of a fire once it is started.

Lopping the tops in hardwoods will not minimize the danger of a leaf fire, although it may possibly do so if the trees are cut in full leaf in the late summer or early fall. If such a leaf fire gets started in hardwoods it is in any event almost certain to kill any reproduction in its way. A further point is the fact that under present conditions the stumpage values of hardwood species are generally too low to justify the extra expenditure that would be involved in any plan of brush disposal. Many large areas of hardwoods can not be operated even now, without any expense of this kind, and undoubtedly the imposition of such a requirement would not only delay the day when such tracts can be operated, but would convert into a loss, or at least very materially reduce, the profits on hardwood operations which are now being carried on in portions of the eastern United States and Canada. Where cordwood is taken out as a part of the hardwood operation, the need for considering brush disposal is very greatly reduced, entirely aside from the financial consideration.

However, as hardwood stumpage increases in value, more intensive methods will become practicable in fire prevention, through the better disposal of hardwood brush. The depletion of the timber resources of the country is rapidly hastening the day. Such action is even now possible under the most favourable conditions. The most encouraging illustration in this respect is the recent sale of the standing merchantable

timber on the Biltmore Estate, North Carolina, at a price of approximately $12 per acre, the ownership of the land being reserved. The removal of the timber is to take place within 20 years, diameter limits for cutting the various species are prescribed, and provision is made for the piling and burning of brush resulting from cutting operations. The latter measure is adopted principally as a fire-protective precaution.

Methods of Disposal.—So far as possible, brush disposal should keep pace with logging. Deep snow may, however, make this impracticable. In case of summer operations, where there is danger of fire spreading, the brush should be piled as the operation proceeds, leaving the burning to be done at a safe time later, as after a rain or a light fall of snow.

Under some conditions, sufficient protection from fire may be secured by the burning of brush so as to form broad fire lines, particularly along railways or wagon roads, laid out in such a manner as to do the least injury to young growth. The necessity for general burning is decreased if an efficient system of patrol is provided.

There are four general methods of brush disposal, which are more or less closely related. These are : (1) Burning ; (2) Lopping ; (3) Lopping and piling ; (4) Lopping and scattering.

Burning.—This may be either broadcast, or following lopping and piling. In the Coast type of the Pacific Northwest, broadcast burning has been found most practicable under certain conditions. This applies to sections where the stand is very heavy and the trees are practically all mature, so that the operation amounts to a clear-cutting, with practically no young growth left worth the extra cost of protection. The slash is left scattered as in old-style lumbering operations and is often 4 or 5 feet deep all over the ground. An efficient fire line is made around the slashing by the removal of all inflammable material on a wide strip. The tract is then burned off, but in order to ensure a clean burn and at the same time avoid danger of the fire spreading beyond control, and into green timber, it is necessary to employ men thoroughly experienced in this line of work, and great care must be used in selecting the time for burning. This procedure results in exposing the mineral soil, thus facilitating the reproduction of Douglas fir, which species is considered of superior desirability. Broadcast burning can be done at a much lower cost than piling and burning. It is reported that under favourable conditions this work can be done for as little as 25 cents per acre. Probably, however, in most cases, it will cost from 5 to 10 cents for each thousand feet of timber cut.

Piling and burning are indicated for sections where the cutting is not clean and where, as a result, the remaining young growth of mature or semi-mature timber must be protected and the fire danger is so great as to require the elimination of the slash menace. This method

BRUSH DISPOSAL ON BIGHORN NATIONAL FOREST, WYOMING

is very frequently adopted in connection with timber sales by the United States Forest Service in the Western States. It must, however, be regarded primarily as a fire-protective measure, and where cutting is done in the winter, as in parts of Minnesota and of the Rocky Mountain region of the United States, it has been found entirely practicable to burn the brush as the operation proceeds. The added cost of piling and burning is in part offset by the greater ease of skidding.

Lopping.—The disadvantages of burning brush will, under some conditions, outweigh the advantages, thus rendering some other form of brush disposal desirable. For instance, in the Adirondacks, the burning of brush is considered impracticable, partly on account of cost and partly on account of the great danger of soil fires, with resultant loss of young and old growth. Silvicultural considerations also enter into the question, and these will be discussed in the course of the ensuing discussion.

The whole theory of lopping brush is that by this means the debris is brought into much closer contact with the ground, so that it will absorb moisture more readily, dry out less in summer, and decay more rapidly than when propped high above the ground. If the work is properly done, brush handled in this way largely ceases to be a fire menace in a very few years, and will practically disappear by decay in from one-third to one-half the time required for brush supported off the ground, as are unlopped tops under ordinary conditions. Following the lopping operation, piling or scattering is usually advisable, unless the added cost renders this impracticable.

So far as known, the lopping of tops as a fire-protective measure, either in Europe or America, was first suggested by Dr. B. E. Fernow in 1890. This suggestion was embodied in his report to the Adirondack League Club on a proposed forest policy for the tract of 93,000 acres of virgin timber land in the Adirondack mountains of New York, which had just been purchased for the use of the Club. This tract was purchased subject to the reservation of all spruce timber above 12 inches in diameter, without restrictions as to methods of cutting. The following statement, quoted from Dr. Fernow's report* will be of interest in this connection :

> "The danger and damage from fire is increased wherever lumbering is carried on, especially from the fact that the leavings, tops of trees and limbs, dry rapidly and lend intensity to any running fire. The proper disposal of these leavings should have been considered in your lumber contracts. In the absence of conditions to that effect the Club must dispose of the matter on its own account.

*Report of the Chief of the Division of Forestry for 1890, page 221. (U.S. Dept. of Agriculture.)

> "It has been urged that the leavings should be gathered and burned. This is expensive and wasteful, and it is my opinion that, at least with the spruce under the conditions before us, it is unnecessary. The danger arises from the fact that the tops braced up by the branches from the soil are dried and kept dry, like tinder. By lopping the branches and letting both branches and tops fall to the ground, it is to be anticipated that the material would be kept wet from the winter snows and soon be rotted. Besides, some useful material for pulp manufacture, which the lumberman would have left, might be saved from this top material. I would at least recommend the trial of this new method. The lopping should be done soon after the felling and it might be possible to make arrangements for this work with the contractor for the lumber."

On account of financial complications, the contract for lumbering the tract was not carried out, and consequently Dr. Fernow's suggestions as to top-lopping did not become effective.

According to Graves, the lopping of tops on an extensive scale was first done in the Adirondacks in lumbering spruce and pine. The plan at first was to cut off only the upper branches of the top. This, however, left the top supported off the ground by the lower branches, so that decay was retarded, and the method was modified to include the lopping of the lower branches, so that the stem and brush could rest on the ground, where decay would be rapid. The piles of brush were packed down by the heavy snows of winter, and in this condition absorbed moisture so rapidly that the fire danger disappeared to a very large extent within a few years.

A later development in some tracts was the scattering of the brush in addition to lopping. The best example of this is on Nehasane Park, the estate of Dr. Seward H. Webb. However, the essential degree of care in getting the brush to the ground has not been generally taken on other tracts, and is not required by the State law, though the self-interest of the land owners would seem to dictate that this action be taken, in order that full benefit may be derived from the expenditure for lopping which the law requires. The situation in the Adirondacks will be fully discussed in the succeeding section of this report.

Lopping and Piling.—This is an improvement upon merely lopping the tops, where no especial attention is given to getting the material either directly on the ground or in piles resting on the ground, and where, consequently, a certain percentage of the brush will inevitably become lodged upon stones, stumps or logs and thus be supported off the ground, where decay will be greatly retarded. Lopping, followed by either piling or scattering, may be preferable to burning, from silvicultural considerations. In dry situations, as in the yellow pine type of the Rocky Mountain region, and especially of the Southwestern States,

BRUSH PILED IN MAIN LOG ROAD, AFTER HAULING WAS COMPLETED, READY FOR BURNING MISSOULA NATIONAL FOREST, MONTANA

the best and often the only reproduction comes up under a fallen tree top or other brush. The ground is shaded and soil evaporation retarded by the presence of a covering of leaves, twigs and brush. Under such conditions, the burning of the brush may make the difference between reproduction and none. The burning of the brush, unless imperative as a fire protective measure, thus becomes undesirable from a silvicultural point of view. Lopping and scattering the brush will facilitate reproduction in this type of forest, but it undoubtedly increases the fire danger during the first few years, so that it is sometimes considered most desirable to lop the brush and pile it at a distance from living trees. This protects the mature timber in case of fire, and, at the same time, encourages the development of seedling growth around the edges of the brush piles, through the shading of the soil and the retention of moisture. In Manitou park in Central Colorado, this method of brush disposal was practised at a cost of 35 to 40 cents per acre. If there is already a satisfactory amount of reproduction on the ground, piling without burning will be preferable, unless the brush can be piled in open spaces so that burning will not destroy the young growth.

Lopping and Scattering.—This has been discussed in the preceding paragraphs. The amount of brush, the degree of fire danger, and the necessity for encouraging reproduction must be considered. The fire danger is decreased by piling, whereas scattering is usually preferable from a silvicultural standpoint. Lopping and scattering is favored for cuttings on second growth woodlands, where the amount of debris is relatively small, as in a mixed forest, where cordwood or pulpwood has been taken out of the tops. In sections where there is danger of soil erosion, or where the reproduction is in danger of being destroyed through browsing or trampling by stock, the lopping and scattering of brush is also preferable, unless other considerations outweigh these.

Brush Disposal on National Forests in Idaho, Montana and Minnesota

Since conditions in the Rocky Mountain region of Canada are practically the same as in that portion of the United States lying directly south of that region the following is quoted in full from a statement by the U. S. District Forester of National Forest District No. 1, comprising Montana, Minnesota, and Northern Idaho :

"Practically the only methods of brush disposal which are in use in this District are piling in high compact piles and burning, piling in windrows and burning, and broadcast burning within fire lines. Lopping and scattering of brush without burning are not considered ade-

quately safe in this region, although I understand it is much used in the southwest. The protection of the soil from drying out by this method is an unimportant advantage, and even in many cases a positive disadvantage in the regions in which most of our timber sales are being carried on, and the extreme fire risk is considered prohibitive. Lopping is, however, essential with any of the three methods in use, as even a broadcast burn cannot be depended on to destroy unlopped tops satisfactorily. The conditions for which the three methods are suited are as follows :

"Brush piling is essential wherever seed trees are reserved, or a selection system of marking is employed. It is the most thorough of the three methods and also the most expensive, the cost varying with the region. The following examples will serve to give some idea of what can be expected under varying conditions :

"On the A.C.M. Company's sale, on the Bitterroot Forest in Montana, from which 37,000,000 feet of Western yellow pine was cut, under the selection system, the actual cost of piling brush was 42.1c. per M. feet B.M., and the cost of burning was 6.7c. per M. feet B.M., or a total of 48.8c. This was in the yellow pine type.

"On the Eureka Lumber Company's sale, on the Blackfeet Forest in Montana, the actual cost of piling was 42c. per M. feet B.M. with the cost of burning unknown. This was in the western larch-Douglas fir type.

"On the Kootenai Forest in Montana, the average cost of brush piling has been estimated by the Supervisor at 25c. per M. feet B.M.

"On the Minnesota Forest in Minnesota, where extensive cuttings have been conducted in eastern white pine and Norway pine, the piling of the brush has been contracted for at 25c. per M. feet B.M., and the burning at 6c. per M. feet B.M. The actual cost of piling the brush is estimated at 18c.

"Wherever possible we consider it advisable to permit some cheaper method of brush disposal. These cheaper methods, however, have not been thoroughly tried out, and our cost data is less accurate. The piling of the brush in windrows is applicable in cases of clean cutting in strips or with reserved blocks or groups of seed trees, particularly in steep country. It entails a minimum of extra labor to the operator, as, in the ordinary process of skidding in steep country, the swampers usually leave the brush in fairly satisfactory windrows in making the skidding trails. It has the advantage in some cases of not exposing the mineral soil over the whole area and kills unmerchantable weed trees, about which the slash may be piled. It is less thorough, however, than brush

piling, unless very carefully supervised, due to the tendency of the swampers not to cut the material fine enough. Its cost on the Cœur d'Alene Forest, in the western white pine type, has been about 10c. per M. feet B.M., including the burning.

"Broadcast burning inside of fire lines has been used in this District, chiefly in the case of fire-killed timber, where the low value of the product to be handled demands a minimum cost to the operator for this item. It is also being used in the case of agricultural land which will be eliminated from the Forests as soon as the timber is removed, and from which our principal aim is to derive the maximum financial return without undue fire risk. Its cost is estimated to be between 5c. and 10c. per M. feet B.M. The essential of this system is, of course, that the exterior fire line be very carefully constructed. This is usually made by clearing a strip about a chain wide with a fire line exposing the mineral soil in its centre for a width of two or three feet. In addition, any snags or stubs standing in dangerous proximity to the line are felled."

Brush Disposal on National Forests in Oregon and Washington

Since conditions are very similar in British Columbia to those directly south of the boundary, in the United States, the following is quoted from a statement by the District Forester of District No. 6, U. S. Forest Service. This District includes Oregon and Washington :

> "The subject of brush disposal in this District naturally falls into two divisions, the disposal of slash by broad-cast burning in the region where Douglas fir is predominant, and the disposal of brush by requiring it to be heaped into small piles and burned, in the region where western yellow pine is the leading species. In this latter division it may be also sometimes advisable to lop and scatter the brush where the conservation of soil moisture and the protection of young seedlings are desired and where at the same time, the fire danger is very small.
>
> In the method of disposing of brush by broad-cast burning, the Forest Service has had comparatively little experience as yet, contrary to what, perhaps, might have been expected. Our large Douglas fir sales are yet scarcely more than two or three years old and consequently the areas cut over have not become very extensive. On a few of the older sales the brush has been burned broadcast at advantageous times in a rather desultory manner, and no record has been kept of the cost of this work. In fact we have had so little experience in it that I would hesitate to guess at any cost figures. On the Snoqualmie Forest, where we have the greater number of comparatively large sales of Douglas fir timber, it has always been planned to burn the slash at the proper time,

but, up to the present, none of these sales has progressed to the point where it has been possible to do so. On two of the sale areas on this Forest the slash caught fire from fires which were burning on adjacent land and burned off the slash at very little expense to the Service with no resulting loss to green timber left standing. These burns, however, were very poor, and the local officers have come to the conclusion that several burns should take place on the cut-over areas before they are in a satisfactory condition for the inception of a new crop of timber.

"The theory and practice of slash disposal in Douglas fir sales, for which we make ample provision now in our timber sale contracts, may be synopsized as follows :

"A fire line from 25 to 35 feet in width is constructed around the area to be slash-burned and is used as a barrier to the limits of the burn. All snags on the area to be burned within the vicinity of this fire line, and wherever they occur on the area in such a manner as to be a fire menace, are first felled. At the most opportune time when the slash can be burned without the escape of fire to adjacent timber the slash is burned and as clean a burn as possible is obtained. This last point is very desirable and probably the hardest condition to obtain. Its desirability is evident on account of the requirement of Douglas fir seed to germinate in mineral soil and to have just as little inflammable debris as possible on the area where the second growth of timber comes up.

"The question of whether the brush should be burned in the spring or in the fall has been much discussed. Each time has its advantages and disadvantages. Spring slash burning is comparatively safe from one standpoint because the ground and litter is still wet from the snows and rains of winter and the fire will not readily spread to areas where burning is not intended. There are several disadvantages, however, in burning the slash at this time of the year. It is often impossible to secure a clean burn because the debris is not sufficiently dry. If all the snags on the cut-over area have not been felled they are apt to smolder for a long time, and may prove to be a constant source of danger in the dry season of midsummer, when a strong wind may fan the smoldering sparks into flames. A smoldering snag, which was ignited during a fire which occurred on July 4, was noticed to be still burning during the week before Thanksgiving, and furthermore, at the time of observation a heavy fall of soft snow was coming down. Another disadvantage of spring burning is that the underbrush will come up after the slash is burned, and the seed bed will not be in such a well prepared condition for the reception of the fall of seed in the autumn.

"Slash burning in the fall is rather difficult because it is hard to start the fire at exactly the right time. A delay in order to secure a moister and consequently safer condition of the debris may be prolonged too long and to such a time that the debris will be so wet that it will not burn. If done at the right time, however, fall slash burning is more thorough because the slash is drier and the

result will be a good clean-up of the debris on the area, leaving the mineral soil in the proper condition for the reception of tree seed at the time of year when the seed is falling. No growth of brush will come up on the area until the following spring when the young tree seedlings will have an even chance with the brush and weeds. If it has not been possible to fell all of the snags, burning in the fall will insure the extinguishment of whatever snags may be smoldering before the next dry season comes around.

"The collection of brush and burning it in piles is universally practiced in the Forest Service timber sales in the yellow pine region of this District. The main principle is to get rid of as much of the brush as possible and at the same time to do the least damage by fire to the timber left uncut, and to the young growth and seedlings. It has been our experience that it costs the timber sale purchaser from 20 to 25 cents to pile the brush, and from four to five cents to burn it in piles, per thousand feet B. M. This costs varies with conditions. In many places where the timber is bushy and there is a large amount of foliage, the cost of piling may run considerably higher than 25 cents per thousand. In one of our large timber sales on the Whitman Forest in eastern Oregon it requires on the average, about one man to pile the brush resulting from the cutting of about 15,000 feet B. M. daily. We are becoming more insistent that the burning of brush piles must be done in such a manner as to cause the least possible damage to timber left standing. In many cases piles should not be burned at all where there is a danger of scorching adjacent timber. You can readily see how futile it would be to mark the timber for cutting, in a most careful manner, and then have a considerable amount of the trees left for seed or protection, or even a second cut, damaged by careless brush burning.

"I am enclosing for your information a circular letter containing instructions for the piling and burning of brush in yellow pine timber which I think you may find interesting.

U. S. FOREST SERVICE

INSTRUCTIONS FOR BRUSH BURNING UNDER THE SELECTION SYSTEM OF CUTTING IN DISTRICT VI.

"In most cases where the selection system is practiced in this District, *i.e.* throughout the yellow pine type and most of the mixed forest types east of the Cascades, the brush is piled and burned in logging operations on the National Forests.

"The following instructions are issued in regard to methods of brush piling and burning in order that this most vital and far too often poorly managed part of our administration of selection cuttings may be handled in the best possible fashion.

"PILING BRUSH.—The first step in successful brush disposal is to secure good piles, and this requires the observance of the following provisions :

"1. The large limbs should be lopped off the tops so that where piles are made on the tree tips, the brush will lie compactly.

"2. Piles should be placed as far as possible from reserved trees of all sizes and from patches of reproduction of all species.

"3. Piles should be made medium in size, *i.e.* they should not be so large that they will make a dangerously large blaze, and they should not be so small that they will be unnecessarily costly to burn or cover an unnecessarily large proportion of the ground.

"4. The debris should be laid on the piles in an orderly fashion, so that they will be compact;—the piles should be *piles* and not heaps of brush.

"5. Large chunks, and heavy limbs free of twigs should not be placed on the piles. Such pieces will not burn up completely, and if charred, will not rot quickly.

"BURNING THE PILES.—The success of the selection method of cutting, as practiced in the yellow pine region, depends upon the proper burning of the brush. If it is not well done, the sale will be bad silviculturally no matter how good the marking or how much care is taken to avoid damage to reproduction and reserved trees. If the brush burning is not done right, our methods of scientific forestry are jeopardized and the selection system of cutting rendered a failure.

"If the burning of the brush piles scorches neighboring trees, runs from pile to pile licking up the reproduction, and now and then jumps from a burning pile into the tops of a group of poles or saplings, all the expense incurred by the Forest Service in doing good marking and by the purchaser in doing careful logging and good brush piling, is of no avail.

"In order to burn the piles so that the least possible damage to the forest will be done, the following points should be observed, whether the burning is done by the purchaser under the direction of the forest officer or directly by the Forest Service.

"1. Each burning crew should consist of but four or five men, who should be in charge of an intelligent, careful foreman. In every case there should be a forest officer to each two crews, and he should be on the ground supervising the burning most of the time while it is in progress.

"2. The lighting of the piles should be done only by the foreman or some other responsible member of the crew, who will use good judgment in applying the torch.* At times when the brush is apt to burn freely, only every other or every third or fourth pile should be lighted, and the balance burned later, or on another day, and thus the intense heat caused by burning consecutive piles will be avoided and the danger of a general conflagration lessened.

* A convenient brush burning torch has been devised by one supervisor. It consists of a piece of light 2-inch pipe, 18 inches long, with a detachable cap or headstop at one end, which is fitted through a reducer to a piece of ⅜ or ⅝-inch pipe 30 inches long. Through the small pipe is run a cotton wick of the same size, its lower end being bent into convenient shape. The large pipe answers as a tank and will hold one quart of coal oil.

Account should also be taken of the direction of the wind in relation to reserved trees, and the torch used with discretion accordingly.

"The balance of the crew should 'chunk up' the piles so that a rim of unburned limbs, twigs, and needles will not be left, and should with shovels confine the fire to the space immediately about the piles.

"3. The foremost consideration in brush burning is to lessen the fire menace from the logging debris in such a way that as little as possible of the reserved timber and young growth will be hurt. It is not necessary, therefore, to burn every pile, for, when an occasional pile is of necessity close to young trees, it is far better to leave it than to burn it and damage them. It is also unnecessary to burn the brush absolutely clean to a bed of ashes. The coarser pieces are not a fire menace so long as all the fine twigs and needles are consumed, and though unsightly for a year or two, they are not so much so as a group of scorched or dying poles and saplings. It is usually better silviculturally to have the piles burn moderately than to have them burn fiercely, and the increased cost of slow burning is amply justified.

"4. In general, the fall is the best season for brush burning in practically every part of the District. On all sales therefore, all the brush piles which have accumulated to date should be burned in the fall and early winter. In large sales where logging is in progress during the winter and early spring, in order to avoid carrying through the dry season a large quantity of brush piles, it may be best to do some spring brush burning. In any event, where a large quantity of brush is on hand in the spring, strips of brush piles should be burned for fire lanes. Begin fall burning as soon as the woods are wet enough, and spring burning as soon as the piles are dry enough. The burning seasons are short and should be made the most of.

"5. The key to successful brush burning is the selection of exactly the right time to do the burning. When the season is right for burning, prompt action should be taken to get the burning crew on the ground. The weather for each day must be considered. On windy days or during the hot mid-days, if the burning cannot be done without danger or damage to young growth, it must be discontinued until conditions are right. On some steep brushy slopes, burning may be safe only when the brush is rather wet or when snow is on the ground. In short, use judgment in selecting the day and the time of day for burning each part of a slashing, *i.e.* do it only at such times as will insure the best silvicultural results, and the administration of the crew should be so arranged as to accomplish this, even though to do so increases the cost of the brush disposal."

The Situation on Private Lands

The Oregon forestry law requires that slashings shall be burned between June 1st and October 1st, and that these fires must be confined

to the owner's land who starts the fire. This law does not apply to the Government lands in the National Forests, but affects all privately-owned lands. The broadcast burning of slash is carried on to a considerable extent under this law, in the Douglas fir type on the Pacific slope, while piling or wind-rowing the brush is necessary in the yellow pine type in the eastern portion of the State.

It is reported by the State Forester that broadcast burning can, under the most favourable conditions, be done for as little as 25 cents per acre. It is doubtful, however, whether this can include the cost of constructing fire lines.

Conditions in Washington and Northern Idaho are closely similar to those in Oregon so far as brush disposal is concerned, except that there is no State law on the subject. However, much is being accomplished through the voluntary action of the lumbermen's organizations, which in part comprise the Western Forestry and Conservation Association. From 75,000 to 100,000 acres of timber are annually cut in Washington.

Brush Disposal Legislation in Minnesota

As in the Adirondacks and elsewhere generally, a catastrophe was necessary to arouse the public of Minnesota to the importance of eliminating the slash menace and to stimulate them to action. The great Hinckley fire of 1894, in which over 400 lives were lost, constituted the first great stimulus, though efficient action was slow in coming. The forestry law of 1895 provided for the appointment of a Forestry Commissioner, but no provision was then made for the enforced disposal of slash. However, the Forestry Commissioner, Gen. C. C. Andrews, at once recognized the desirability of such action and, through his influence, a bill was introduced in the legislature providing that the State should burn the slashings if the operators did not, the cost to be charged against the owner of the land. The measure was, however, too advanced for the times, and it failed because of strong opposition on the part of the lumbering interests.

In 1902, an object-lesson was provided by the passage by Congress of the Morris Act, drawn by Gifford Pinchot, regulating logging on the Chippewa Indian Lands in Minnesota, including the Minnesota National Forest. This act required purchasers who cut pine timber "to burn or remove a sufficient amount of the tops and refuse to prevent danger from fire to the timber left standing." The regulations prescribed under the law have worked satisfactorily and have demonstrated conclusively that brush disposal is entirely practicable. As a rule, the brush has been burned as the operation proceeds.

LOGGED OVER AREA AFTER BEING SLASH-BURNED. PACK RIVER FLATS, IDAHO

The slash problem not having been solved, as to privately-owned lands, a second stimulus was furnished by the great Chisholm fire of 1908, which burned over a large area of slashings, wiped out the town of Chisholm, destroyed an enormous amount of property and endangered many lives. The moral effect of the Morris Act had also an undoubted effect. The result was the passage in 1909 of a law requiring the piling and burning of all slash resulting from wood cutting operations. Burning was to be completed as soon as conditions would permit and before the first day of May. The opposition of some of the lumbermen and the lack of sufficient funds for enforcement were responsible for its failure, together with the fundamental weakness of the law in that it provided only one arbitrary method for meeting all the widely diverse conditions in the State.

The law of 1909 proving unsatisfactory, it was repealed by the enactment of the Forest Law of 1911. The section of the law which relates to the disposal of brush is as follows :

> "Sec. 15. Where and whenever, in the judgment of the state forester, there is or may be danger of starting and spreading of fires from slashings and debris from the cutting of timber of any kind and for any purpose, the state forester will notify the individual, firm or corporation, by whom the said timber has been or is being cut, ordering the n to dispose of the slashings and debris as he may direct. Where conditions do not permit of the burning of the slashings and debris over the entire area so covered, the state forester may require the person, firm, or corporation, by whom the timber was cut, to dispose of such slashings and debris in such a way as to establish a safe fire line around the area requiring such protection, the said fire line to be of a width and of a character satisfactory to the state forester.
>
> "When any person, firm or corporation shall have been notified by the state forester to dispose of slashings and debris, either by entirely consuming the same or establishing a fire line sufficient for the protection of adjoining property, and fails to comply with such instructions, the said person, firm, or corporation shall be deemed guilty of a misdemeanor, and on conviction thereof shall be punished by a fine of not less than $50.00 and not exceeding $100.00 and costs of prosecution for each violation thereof or failure to comply therewith.
>
> "When any such branches, slashings or debris are left unburned contrary to the instructions of the state forester, the state forester may go upon the premises with such force of men as may be necessary, and burn such branches, slashings and debris, and the expense thereof shall be a lien upon the land on which they are situated, enforced as liens for the improvement of real estate are enforced, and such expense shall be a *prima facie* valid claim that may be collected from the person, firm, or corporation who cut the timber or wood from which the said slashings and debris were made."

Although the law has been in effect for only one year, it appears to be working satisfactorily, due in part to its elasticity, and in part to the provision of more adequate machinery for enforcement. The Forest Rangers are given authority to act directly, on behalf of the State Forester, and they prescribe the measures to be taken in each case, after a careful consideration of all the conditions on the ground.

The object of slash disposal is to eliminate the fire danger. The methods adopted have a three-fold purpose : (1) To remove the immediate fire danger ; (2) to prevent injury to standing timber remaining on the cut-over area or adjacent to it ; and (3) on land which is not to be used for agriculture, to prevent the clean burning over of the land, thus preserving the young growth, the tree seed already on the ground, and the ground cover and soil itself.*

As in the Adirondacks, burning is generally considered impracticable in spruce and cedar, and lopping is the standard procedure. In pine, piling and burning are prescribed under ordinary conditions. The exercise of much judgment is, however, necessary, in determining the procedure for any specific tract, since conditions vary so widely. As a general guide, the following rules were agreed upon at a meeting of the district rangers held at Bemidji, Minn., January 3rd, 1912 :*

> (1) "Where trees are scattered, or the country is generally very rough and rocky, clean burning is inadvisable. In such cases, a fire line of at least 150 feet in width should be burned around each area of slash, and along rights-of-way." This rule is based upon the theory that, where the trees are widely scattered, their brush will not constitute a serious fire danger. Clean burning would entail a needless expense upon operators. The second part of this rule is based upon the theory that the rocky country would be non-agricultural, hence, forest land. Clean burning would effect to a greater or less extent the destruction of what meager ground cover is usually found in such rocky country, and, in some cases the soil itself, of valuable reproduction and any timber that might remain, and of seeds which have fallen to the ground. To reduce this destruction to a minimum is one of the fundamental principles upon which slash disposal is carried out, hence the rule. Another point to be considered here is that the unburned brush retards evaporation of soil moisture. Also, in decaying, the debris adds to the valuable humus. Where slash from a thick stand of timber, even if on non-agricultural land and surrounded by a fire-break, will in future be a menace to adjoining green timber not to be cut, this rule is often extended to include clean burning. The latter is usually required to be done as cutting proceeds, in order that damage to the soil, young timber, and seed, may be avoided in so far as possible.

*First Annual Report of State Forester of Minnesota, 1911, pages 67 and 69.

(2) A corollary to the above rule is : "In cases where clean burning is not required, in addition to a fire-break of not less than 150 feet in width, to be burned around such an area of slash, a strip not less than 150 feet wide should be burned along each side of any form of right-of-way traversing the slash area. This general rule applies specifically to logging railroads in all locations, and will be of value not only in connection with clean rights-of-way, decreasing the danger of fire being set by locomotives, but in order that the strips may serve as lines of defence in fighting fires.

(3) "Where the land being cut over is to be cleared and used at once for agriculture, piling and clean burning is advisable." Clean burning will ordinarily be done in any event on such lands. It is best that it be done under supervision of forest officers and at a specified time. This is advisable because many forest fires have originated from the burning of brush on farm lands at wrong times.

(4) "Where operators have been permitted to postpone one burning until spring, when the snow is going or gone, times should be selected for burning when the fire will not run freely on the ground. A sufficient force of men should be on hand to surely prevent fire escaping." The selection of times for burning when the fire will not run on the ground has a dual purpose. It is this : When fire will run on the ground the danger of its escaping is increased. Furthermore, running fires are ruinous to any valuable reproduction which may exist, of any seed which may lie on the ground, and to the ground cover itself.

(5) "In piling brush for burning, care should be taken not to make piles in close proximity to any green timber, old or young, which may have been left standing. This will prevent the injury of the trees when the brush is burned." The rule should be especially observed in regard to mature trees which have been left standing to secure reseeding. Equal care should be taken in regard to young timber left standing on forest ground.

(6) "Whenever circumstances will permit, required burning should be done during the winter, as cutting proceeds." This, because winter burning as cutting proceeds insures the proper disposal of the slash, and leaves no opportunity for the operator to neglect the work. Furthermore, it is usually the cheapest method of securing effective disposal. Also, when a large area of slash is left unburned until spring, there is always a chance that the snow will disappear rapidly and be followed by a dry period. Thus, unless the work of burning is begun and diligently pushed as soon as conditions will permit, serious danger of fires escaping will occur. Accordingly, the work of burning may then in some cases have to be discontinued before completion. Hence, dangerous areas of slash may exist in the fire season which would not occur had the slash in question been burned closely behind the cutting.

The six rules in the above series apply particularly to pine slash. Rules 4 and 5 apply to any form of slash which is to be burned.

The rules to follow apply in each case especially to the types and species named therein :

(7) "Where cutting operations are being carried on in spruce or cedar timber, the branches should be lopped separately from the unused tops, so that every one lies flat on the ground." One reason for this method of procedure is that these species grow largely in swamps, ordinarily more moist than the uplands ; hence, decay there is more rapid. The branches lying on the ground are uniformly damp in summer. They are not so pitchy, and rot more quickly than pine, and are therefore not so dangerous. If the large tops commonly to be found in spruce and cedar cutting, held high from the ground by their branches, are left intact, they dry out, remain for years, and fire will sweep through them readily. Usually, in spruce and cedar forests there are large numbers of young healthy trees, too small to be merchantable, which often stand very closely together after the larger timber has been removed. It is the policy of the Service to protect such young valuable timber. Piling and burning of the brush could not, in the majority of swamps be carried on without serious injury to it. Furthermore, if burning were required, and was not done in the winter, there would be a probability of the fires getting into combustible peat soil on which spruce and cedar often grow. Other things being equal, another reason why lopping is more advisable than burning in the treatment of these forms of slash (even on spruce on high land) is that piling and burning is relatively more expensive than in pine timber. The reason is that there is a greater proportion of branches in comparison to merchantable timber resulting from operations in spruce and cedar than in pine. Hence, it is cheaper to merely lop the branches than to lop, pile and burn. The relative efficiency of two possible methods of disposing of a given area of a slash being equal it is the policy of the Service to require the use of the cheaper method. Since lopping in these species (spruce and cedar) is as effective in removing the fire danger as is piling and burning, and since other considerations render lopping the more advisable, the latter is the method usually required. A very considerable obstacle in the way of securing proper lopping is the fact that much of the spruce pulpwood, and cedar tie, post and pole operations, are carried on upon a piece-work basis ; that is, laborers are paid a flat rate per cord in pulpwood, and per piece in the cedar operations. They pay their own board, furnish their own tools, and are at liberty to do as much, and to a certain extent, as little work in a day as they wish. Consequently, any work which tends to cut down the number of cords or pieces which a piece worker can turn out in a day, and for which he is not especially paid, is avoided wherever possible. Heretofore, no provision has been made to allow of paying of piece-workers for lopping. Until some method is evolved by which this obstacle can be overcome, such as increasing the rates paid per piece, it is a difficult matter to secure thorough observance of the lopping requirements. In the meantime, it has in some instances been found necessary to allow operators to construct a safe fire-break, not less than 150 feet in width, around the

cutting areas and along rights-of-way. Since the slash disposal law is now generally understood, every operator should make provision for handling this situation next winter.

(8) "Hardwood slash should be disposed of by lopping as cutting proceeds, or by the burning of adequate fire-breaks around the areas of slash." The hardwood forests of Minnesota grow on land that is good for farming, unless too rocky. Therefore, the slash resulting from cutting operations will in a majority of cases be burned sooner or later, to put the land in shape for tilling. The above rule is devised to prevent the escape of fire from burning brush and to preserve remaining timber.

Part III

The Top-Lopping Law in the Adirondacks

This discussion is included in this report on account of its close bearing on the brush-disposal situation in Eastern Canada.

Following the very severe fires of 1908 in the Adirondack mountains, public sentiment in the State of New York became strongly aroused, and it was generally realized that the existing forest fire laws were not sufficiently effective. Accordingly, Commissioner Whipple of the State Forest, Fish and Game Commission, called a conference of various land owners, lumbermen and others interested in the Adirondacks, for the consideration of this problem.

The stake of the lumbermen in the Adirondack region is only a very small percentage of the interest of the general public. For every dollar represented in stumpage values, probably ten to twenty dollars must be expended in connection with the manufacture of the raw material. It is thus seen that the interest of the general public in the protection and perpetuation of the forest is not less than ten times as great as that of the individual timber owner.

It is probable, also, that the Adirondack region is sought for purposes of recreation or health each year by a larger number of people than is any other portion of the United States or Canada of equal area. The insistent demand of these large and influential elements, in addition to the desires of the many who were interested solely from a business point of view, made radical action imperative.

It was realized from the beginning, that, not only do a very large percentage of the fires start in old slashings, but also that these fires are very much more difficult to control under ordinary conditions than fire in the virgin forest, owing to the vast accumulation of inflammable material. The presence each year of a large number of hunters, fishermen, and other pleasure or health-seekers in the Adirondack region, renders the existence of the large amount of inflammable debris in the woods a much more serious matter than would be the case under other and more ordinary circumstances.

Although the burning of brush in connection with a lumbering or pulp operation is feasible, and is very desirable when the slash is heavy and the fire danger great, the cost was considered prohibitive as to privately-owned timber lands. There was also to be considered the un-

AN UNLOPPED SPRUCE TOP

TOP PROPERLY LOPPED, RECENT CUTTING, BRANDRETH PARK, ADIRONDACK PRESERVE

doubted danger of starting fires which will burn indefinitely in the duff in addition to the danger of destroying more or less young growth and mature standing timber. Cutting operations are carried on during the summer months, so that burning of brush as a regular part of the operation is clearly impracticable. The only way the situation could be handled, were the cost not prohibitive, would be to pile the brush away from living trees and burn the piles at a favourable time, as in the fall when the ground is wet on account of rain or snow. This method was, however, eliminated on account of cost.

After much deliberation, the Committee appointed by the Conference, decided that the enforced lopping of tops of coniferous species was the most feasible measure that could be considered in connection with the lessening of the slash menace on future operations. Therefore, the Committee, on which the lumbering interests were strongly represented, recommended the enactment of legislation which became law early in 1909, in the following form :

> "Every person who shall, within the forest preserve counties of the state, cut or cause to be cut, or allow to be cut any coniferous trees for sale or other purposes, shall cut off or lop or cause to be cut off or lopped from the said trees, at the time of cutting the said trees, all the limbs or branches thereof, unless the said trees be cut for sale and use with the branches thereon."

During the four summers that have elapsed since the passage of this law, climatic conditions have been such that fire danger has been very materially lower than in 1908. In addition, the severe lessons of 1908 and of previous years have resulted in a very much more efficient State fire protective organization, in the form of special patrols and a system of mountain lookout stations. The extent and efficiency of the lookout station system has been increased through the co-operation of the Federal Government under the terms of the Weeks Law, which provides for co-operation with states for the prevention of forest fires on the watersheds of navigable streams.

The fire danger has also been very materially decreased through the issuance in 1909, of an order by the Public Service Commission of the State of New York, requiring the use of oil as fuel on locomotives running through the Adirondacks in the day time, between April 15th and November 1st of each year. Naturally the worst and most extensive slashings in the Adirondacks were to be found along, or within, a few miles of the railways, since ease of transportation is the governing consideration in determining whether lumbering operations on a particular tract are financially practicable. At the same time, the danger of these slashings catching fire from the coal-burning railways was very great, on account of the escape of sparks from the locomotives and of

burning coals from the fire-box. The use of spark-arresters and of other fire-protective appliances did not provide satisfactory protection under the extreme conditions then prevailing. Thus, the issuance of this order by the Public Service Commission practically eliminated what was probably the most serious source of fire danger in the Adirondack region.

However, while the fire danger has decreased in these several ways, and the impressions from the severe lessons of 1908 have grown dim with the passage of time and with the cessation of public clamor for effective action, the operators have constantly felt the added expense imposed upon them by the law. They have felt also the annoyance caused by the readjustment to new methods of woods work imposed by the existence of state regulation of their business. The result has been a gradually increasing protest against the law on the part of many who accepted it without protest in 1909, for fear worse might befall as a result of the then thoroughly aroused public sentiment. It is quite possible also that the feeling against the law may be somewhat intensified on the part of some timber owners by the fear that the top-lopping law may prove but an entering wedge for the wider regulation by the state of the lumbering industry.

As a result of the objections to the law, and of the adverse representations made as to its operation, three hearings were held during the week of September 30, 1912, by the Superintendent of State Forests, representing the State Conservation Commission. These hearings were held at Watertown, Saranac Lake and Glens Falls, N.Y., and a very complete discussion of all phases of the situation took place. It developed at these hearings that a wide diversity of opinion exists as to the merits of the law and as to the soundness of the fundamental theory upon which it is based. It was found also that while many operators are wholly opposed to the law, both in theory and in practice, others defend it just as vigorously ; while a third class exists of those who maintain that the law has not yet been in operation for a sufficient length of time to demonstrate whether it should be continued, repealed or amended, and that a longer trial is necessary before any radical action adverse to the law is justified.

It was evident at the hearings that many of the arguments, both for and against the law, were based more or less upon personal opinion, without sufficient basis of careful observation of the actual results on the ground. Arrangements were therefore made for a field investigation by the State Forester, F. A. Gaylord, accompanied by a number of prominent lumbermen or their representatives. Through the courtesy of C. R. Pettis, Superintendent of State Forests, the writer was allowed to accompany the party as a representative of the Commission of Con-

servation of Canada. Similarly, T. W. Dwight, accompanied the party as a representative of the Forestry Branch, Department of the Interior. Acknowledgment should here be made of the value in the preparation of this report of the discussions with and suggestions received from Messrs. Gaylord and Dwight, as also from W. C. Bagg, forester for Finch, Pruyn and Company, large pulpwood operators in the Adirondacks.

The party spent the week of October 28th in a careful examination of the results of top-lopping on a number of representative tracts in various sections of the Adirondacks. These will be discussed in some detail later in this report. It should be understood that the lopping operations carried on prior to 1909 were wholly voluntary, and were carried on partly to minimize danger from fire and partly to improve the looks of the forest and facilitate its use for park purposes. The observations made were all in the spruce section of the Adirondack region. The cutting operations of recent years have been for the most part in spruce and balsam. Hardwoods have been logged only to a very limited extent. The original growth of white pine in this section was to a very large degree cut out many years ago, and areas where young growth white pine was left from the earlier cuttings, have been gone over repeatedly in later years for this valuable species. The white pine region proper, on the eastern slope of the Adirondacks, was not visited in connection with this investigation. It is understood, however, that there is comparatively little objection in that section to the operation of the top-lopping law, the principal objection coming, as stated, from the operators in spruce and balsam. Another way of stating the same point is that in general it is not the operators in saw-timber but those in pulp wood from whom the objection is coming. Nor should it be understood from this that all the pulp men are opposed to the law, for such is not the case.

In order to make the situation clear, the following summary of objections is here given. It should be understood that this summary includes the principal objections raised from all sides, and is not necessarily a statement of the opinion of any individual.

Summary of Objections.—Fires in lopped tops burn deeper, harder and faster, and are harder to fight, than fires in unlopped tops ; lopping does not materially if at all increase the rate of decay of debris, and is therefore ineffective as a fire preventive measure. The conditions resulting from lopping are more unfavourable to young growth, both present and future, and to the remaining old forest than where tops are not lopped ; and the beneficial results, if any, are not commensurate with the cost to the operators and land owners.

Summary of Conclusions.—In advance of discussion the following summary of conclusions is here inserted :

1. Increasing stumpage values render fire prevention and control essential from the point of view of the timber owner. Decrease in wood supplies renders it still more essential from the point of view of the general public, and, in particular, of the communities and business interests directly dependent upon the manufacture of forest products.

2. Logging slash constitutes the most serious fire menace in existence.

3. Brush disposal is a practicable and feasible method of minimizing fire danger, though secondary to patrol.

4. The method of brush disposal to be adopted in any particular case can be determined only by careful consideration of all the surrounding conditions. It is desirable that the administrative officers should have a reasonable degree of discretionary authority.

5. Where brush-burning is practicable both financially and silviculturally, this is the most efficient means of reducing the slash menace.

6. Where brush burning is not practicable for any reason, the lopping of tops may be advisable. In case tops are lopped, financial and silvicultural considerations will determine whether the material should be piled or scattered, or left without further attention. The necessity for lopping may under some circumstances be obviated by some other fire-protective measure, such as the construction of fire-lines, etc.

7. The lopping of tops does materially increase the amount of debris which reaches the ground or forms piles resting on the ground in sufficiently compact form to absorb and retain moisture ; the time required for decay is thus lessened by one-half to two-thirds. The slash menace as an element of fire danger disappears in direct proportion to the rapidity and completeness of this process of decay. Piling or scattering, following lopping, is desirable, but is generally considered to be impracticable in the Adirondacks on account of expense. This would apply also to a large section of Eastern Canada, unless such disposal is required under a Government license, and allowance is made for the added cost in dues to be paid.

8. With closer utilization, the relative efficiency of top-lopping as a fire protective measure decreases. In other words, lopping is much more necessary in an old-time lumbering operation and will have a great-

er relative effect in decreasing the fire danger, than in case of a pulp operation, where a far larger percentage of the branches will in any event be brought into contact with the ground, as a necessary part of the operation.

9. The beneficial effect of top-lopping far outweighs the disadvantages due to any possible injury to soil, reproduction or old growth.

10. Lopping to only a 3-inch diameter limit in the lop materially decreases the cost of the operation ; this modification may be justified in sections where the fire danger is not extreme and where cost is a determining consideration.*

11. The question of brush disposal and of fire prevention in general should be given much more careful attention in Canada by all concerned than has been the case in the past. This is entirely practicable in case of issuance of new licenses by Dominion or Provincial Governments, as well as in the case of renewals of existing licenses.

12. Patrol is the most important and the most essential element in any plan of fire protection. This must be provided, regardless of what other methods are adopted. The construction of roads, trails, telephone lines, lookout stations, and other permanent improvements of a similar character is essential to an efficient patrol system.

Discussion

The arguments for and against the top-lopping law, and the conclusions resulting from the field trip above referred to, can most advantageously be discussed together. For convenience, this discussion will be divided into four general heads, concerning the effect of the top-lopping law, as to :

(1) Fire Danger

(*a*) Prevention

(*b*) Control

* Since the preparation of this report the Legislature of the State of New York has amended the top-lopping law with relation to the 3-inch diameter limit to read as follows :

"Every person who shall, within any of the towns enumerated in section 97 of this chapter except as hereinafter provided, fell, or cause to be felled, or permit to be felled any evergreen trees for sale or other purposes shall lop, or cause to be lopped from the said trees and the limbs thereof, at the time of felling the said trees or at a time to be fixed by the commission as hereinafter provided, all the limbs thereof up to a point where the trunk or branch has a longest diameter which does not exceed three inches, unless the said tree be felled for sale and use with the branches thereon or for use with the limbs thereon."

(2) Effect on the Future Forest

(*a*) Existing and future reproduction
(*b*) Soil

(3) Effect on the Remaining Old Forest

(4) Effect on Cost of the Operation.

(1) Effect as to Fire Danger

It is maintained by opponents of the law that lopping increases the fire danger instead of diminishing it, at least for the first few years ; and that a fire in lopped tops burns harder and faster, and is harder to fight, than is a fire in unlopped tops. It was even seriously maintained by some that unlopped tops will decay more quickly than lopped ones, since brush in the air is more fully exposed to the elements than it is on the ground.

(1-*a*) Fire Prevention

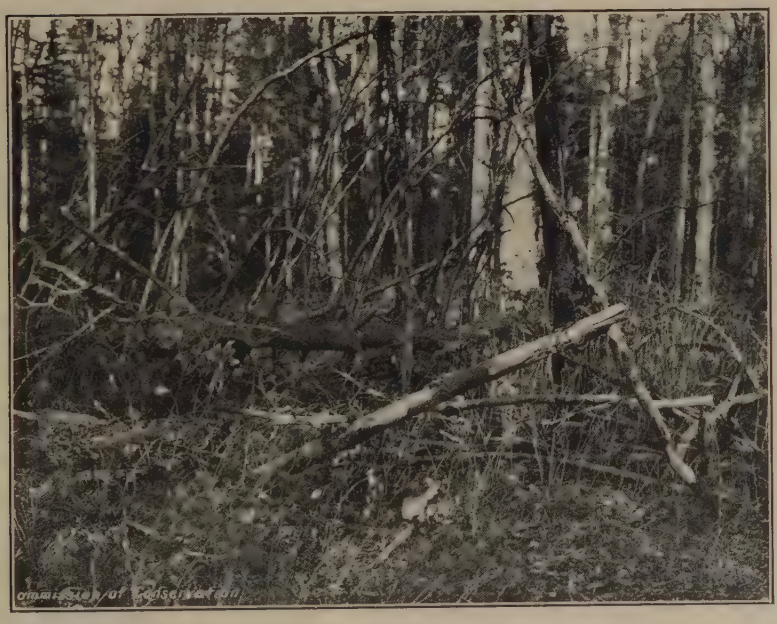
The point as to relative rapidity of decay is fundamental, as far as the question of fire prevention and control is concerned. The whole theory of laws or regulations providing for the lopping of tops is that the debris will thereby be brought into closer contact with the soil, thus facilitating decay and concentrating into a much shorter period of time the existence of that part of the fire danger due to the slash.

Beyond this is the crucial point as to whether more material is, as a matter of fact, brought into contact with the ground by lopping than by not lopping. Some of the opponents of the law take the adverse position on this point, even though they may admit that brush will rot quicker on the ground than in the air. Unquestionably if this position can be sustained, the additional expense involved in observance of the present top-lopping law is not justified, and it should either be repealed or so modified as to make it really effective.

Rapidity of Decay.—With regard to relative rapidity of decay, all observation as well as all theory sustains the contention that brush will rot more quickly on the ground than in the air. It follows that in so far as lopping tends to bring the debris into contact with the soil, either scattered over the surface, or in piles resting on the ground, decay will be more rapid than if the tops are left unlopped and are supported off the ground by the lower branches. It is also equally true that the expense incurred in lopping tops may be in large or small part wasted through allowing the brush to remain supported off the ground by stones, stumps, or logs. This frequently happens when the

REMNANTS OF TWO LARGE SPRUCE TOPS TEN YEARS AFTER BEING PROPERLY LOPPED

The vast majority of tops on this operation have entirely disappeared. Nehasame Park, Adirondacks. (Courtesy of N.Y. Public Service Commission.)



UNLOPPED TOPS, LITTLE TUPPER LAKE, WHITNEY TRACT, ADIRONDACK PRESERVE

Fire has run through this top, extending to the tip of the upper branches, consuming the finer material and carrying fire to the adjoining live balsam.

brush is thrown aside to make room for the construction of skid-roads without any thought as to the underlying theory of the top-lopping law, or any intelligent desire to secure the fullest possible benefit from the expense which the enforced observance of the law entails.

The partial failure of top-lopping to accomplish its object on account of this neglect is particularly noticeable in the case of single branches of small piles. When these are supported off the ground by falling across stones, stumps or logs, the effect is practically the same as though they were supported in the air by the stem to which they were originally attached, and decay is relatively slow.

On the other hand, large piles of brush, even though supported above the ground by resting on stones, stumps, or logs, or in any other way, gradually settle down through the weight of recurring snows, and quickly become sufficiently compact to hold moisture, thus facilitating the process of decay. This process is more rapid in a mixed forest than in one of pure spruce and balsam, since the fall of leaves from the trees of hardwood or broadleaved species, quickly covers the tops of the brush piles, preventing the sifting of the snow among the branches. Thus, the weight of snow on top of the piles is greatly increased, causing the finer branches on the interior of the piles to come into sufficiently close contact, so that they can retain a portion of the moisture which will necessarily trickle through from above. In this way is supplied the element, which in addition to heat and air is essential to the growth of the fungus, the development of which constitutes the process of decay. Where piles of brush rest on the ground, moisture is available from below, as well as from above, so it follows logically that, under these conditions, decay will be most rapid.

It is universally recognized in other connections that the conditions essential to decay—the presence of heat, moisture and air,—are found in most favourable combination at the surface of the ground rather than above or below the surface. Fence posts and telegraph poles decay most quickly where they enter the ground. Fuel, pulpwood, and saw-logs are always raised off the ground by skids in order to prevent decay at the bottom, if they are to remain in the woods for any length of time. The woods operator always gets his logging sleighs off the ground during the season of the year they are not in use, his object being to prevent decay of the wood-work and consequent loss of strength. The application of this general principle to brush disposal is just as complete as in any other connection, and it seems almost inconceivable that such an objection could have been seriously advanced in connection with the top-lopping law.

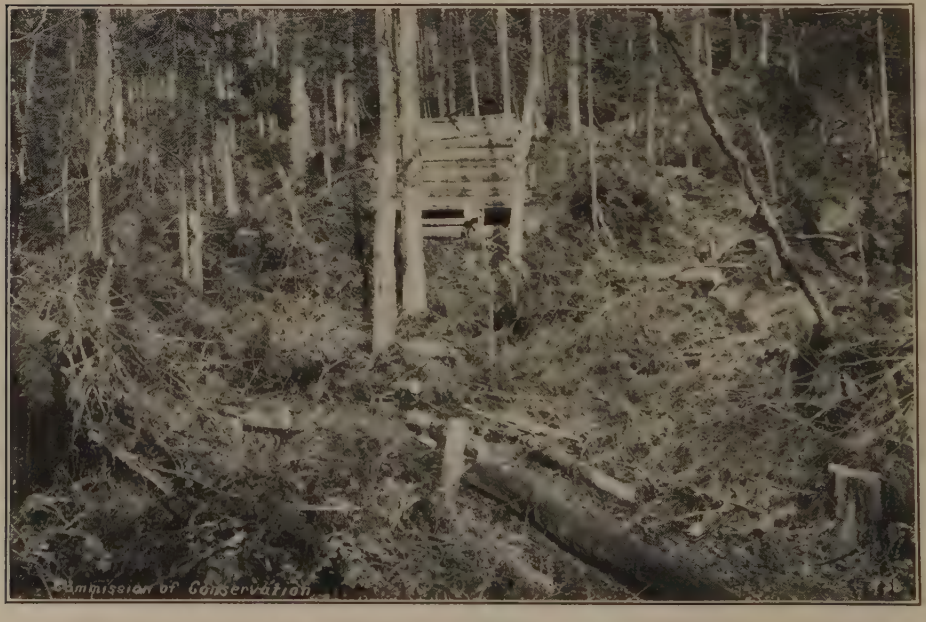
It is also undoubtedly true that the lopping of tops does bring a larger percentage of this debris into contact with the ground than non-lopping. In an ordinary lumbering operation, where the utilization into the top is not close, this could not be seriously questioned, as the difference in this respect would be obvious to the most casual observer. It must, however, be borne in mind that, in the Adirondacks, a very large percentage of present-day operations are for pulp rather than for lumber, and that the material is utilized from the top down to a diameter limit of four or five inches on an average. In this way, instead of the tops being left in the woods below a diameter limit of eight or ten inches, as in a lumbering operation, 75 per cent to 90 per cent of the branches must be lopped as a necessary part of the operation in getting out the pulpwood. This leaves affected by the top-lopping law in the Adirondacks, aside from culls and small trees brushed out for roads and skidways, only tops below an average diameter limit of four or five inches. It will thus be seen that there is less necessity for a top-lopping law in a pulp operation than in one for lumber only, as a result of the much closer utilization in the former. The fire danger, which primarily led to the enactment of the top-lopping law, was probably for the most part due to slash resulting from lumbering, rather than from pulp operations. This may to a certain extent explain the present lack of sympathy with the law, on the part of some of the pulp operators.

If the tops are not lopped, the bulk of this debris can not come in direct contact with the ground except in rare instances, as when the top is broken down in falling, or when another tree falls across it. Decay will thus be relatively slow, since only the ends of the lower branches will touch the ground, and since it takes many years for the lower branches of a top to rot away sufficiently to let the main stem rest on the ground, where decay will be facilitated. The upper and side branches usually persist until this process takes place, especially in the larger tops, where the percentage of heartwood is high and the branches are correspondingly stronger. The smaller tops resulting from a modern pulp operation have a larger percentage of sapwood and will thus decay more rapidly, either in the air or on the ground, than large tops under similar conditions.

On the other hand, where tops are lopped, the branches must be disposed of in the same way as those cut from that portion of the stem which is utilized. This will usually be a combination of both scattering and piling even though no extra pains are taken in this connection. In the ordinary operation, the great majority of the lopped branches from the utilized portion of the tree fall either directly on the ground, or in piles which rest on the ground. A minority will be supported

RESULT OF FIRE OF MAY 20th, 1911, IN PILE OF LOPPED TOPS, CUTTING OF 1909, SPERRY POND, WHITNEY TRACT, ADIRONDACK PRESERVE

Pile had not dried out on bottom, so that fine material at bottom of pile did not burn nor did the larger branches on the top of the pile. Thus the fire did not burn into the ground nor make a hotter fire than if the tops were not lopped. Shows that spring fires in lopped tops are not necessarily hotter than when tops are not lopped.



LOPPED BRUSH PILING AND SKIDWAY OF PULPWOOD CUT ON SANTA CLARA LUMBER CO.'S TRACT, ADIRONDACK PRESERVE

Heavy stand of spruce. Note dense mass of brush on the ground. Practically a clean cut of spruce and balsam. Brush piled along road to make room for skidding, but little, if any, extra trouble taken to pile lopped tops.

above the ground, either singly or in piles, by stones, stumps or logs. There is no reason to assume that the percentage of the branches lopped from the trees failing to reach the ground, or piles resting on the ground, will be any greater than in the case of branches necessarily lopped from the lower portion of the tree utilized for lumber or pulp. In fact, the probabilities are that the reverse is the case. It is, however, obvious that lopping the top must necessarily result in a material increase in the total amount of brush reaching either the ground or piles resting on the ground, and thus the fire danger will be decreased through the quicker disappearance of this class of material.

As previously indicated, it must also be recognized in this connection that there are various degrees in the efficiency of top-lopping as a fire-protective measure, depending upon the extent to which the material is brought into position to receive moisture from the soil. Rapidity of decay is also influenced both by the heaviness of the cutting and by the amount of shade after the operation. Where the cutting is heavy, resulting in a great amount of brush, there will be a larger percentage in piles, the piles will be higher, and a greater percentage of the debris will be supported off the ground, being thrown across stones, stumps or logs to get it out of the way of the road building and skidding operations. On the other hand, where the cutting is light, the reverse conditions will obtain, and, in addition, the remaining trees left uncut will shade the ground, assisting in the retention of the moisture and thus facilitating decay.

This effect is particularly noticeable where pulp is cut in a mixed forest of hardwood and spruce. The hardwoods and the smaller spruce remain uncut and afford a higher percentage of crown cover, so that the ground is shaded and the soil moisture is protected from rapid evaporation. The same conditions obtain in a stand of pure spruce where only the larger trees are removed, leaving a sufficiently heavy stand to prevent wind-fall and to shade the ground. In case of a heavy cutting, a thick growth of shrubby plants will come in under some conditions, thus furnishing shade and facilitating decay. Where the cutting is heavy and there is relatively little shade from the trees left standing or from the ground growth of shrubs, the soil dries out and decay is relatively slower.

Tracts Visited.—Detailed observations made on the tracts observed fully bear out these conclusions.

Everywhere on old unlopped tops, the under branches on the ground are more rotted and have fewer fine branches than on the top side. The same was observed of brush in piles, where the fine branches disappear much more quickly on the ground and in the lower portion of piles than where exposed to the drying effects of sun and wind.

In this connection, it must be borne in mind that the fire danger due to the presence of brush is not so much from the larger branches as from the small ones. It is the latter which ignite so readily when dry and which carry the fire so fast in a dry time that control is often impossible in old slashings.

The lopping on Nehasane Park was done 12 years ago (1900), under the forest working plan prepared for Dr. Seward H. Webb, by H. S. Graves, now Chief of the U. S. Forest Service. This tract affords probably the best example of the beneficial results of top-lopping to be found on the continent to-day. The lopping was properly done and the brush has now practically disappeared. The reproduction of spruce and balsam is very fine. The cutting was for lumber and material was removed only to a top diameter limit of approximately 10 inches. Tops up to a foot in diameter which were so lopped that they rested on the ground have either entirely disappeared or are so completely rotted that they can easily be kicked to pieces. In this condition there is practically no fire danger as the wood is too wet to burn under any ordinary conditions, and would not make a blaze even if dry.

Where for any reason a top was not properly lopped, or brush was left suspended in the air by stones, stumps, or logs, the process of decay has proceeded with exceeding slowness and this material will still burn. The Superintendent of Nehasane Park stated that in his opinion the fire danger resulting from the lumbering operation on that tract practically disappeared at the end of eight years.

On the old Dr. Webb cutting of 16 years ago, (1896) on what is now the Brandreth tract, the brush which was properly lopped and piled has practically disappeared. What is left is the material in the relatively numerous unlopped tops and in tops which were lopped and left lying across stones, stumps, or logs so that it remained in the air. The lopping on this tract was not so well done as on the Nehasane tract, and for this reason the process of decay has not been so complete. This must be considered in estimating the efficiency of the New York top-lopping law, since, as indicated, only lopping is required, with no direction as to getting the material on the ground. It is not to be expected that as great care will be taken under the top-lopping law in getting the material on the ground as was exercised on the Nehasane tract. However, it is undoubtedly true that a very large percentage of the debris will, under the ordinary observance of the law, reach the ground, or piles resting on the ground, and the decay of this material will within a few years result in isolating the balance of the debris to such an extent that its character as a serious fire menace will very largely disappear.

In the 3-year-old cutting of the Santa Clara Lumber Company, the piles of lopped tops have already settled materially toward the ground, while the unlopped tops are standing off the ground, supported by the branches, without any appearance of material change since the time of cutting.

On the 21-year-old cutting area of the Santa Clara Lumber Company the tops were not lopped. The operation was for lumber only, and little cutting was done below a top diameter limit of 8 or 10 inches. Many of these unlopped tops are still standing in the air supported by the branches. On the other hand some have settled to the ground, while undoubtedly others have entirely disappeared. The tops lying on the ground still have, as a rule, their upper and side branches in a fairly sound condition. The slow process of decay leaves a soft fuzzy coating on the outside of each branch standing in the air which would enable a fire to cover the whole surface of the limbs.

Similar conditions were observed, and similar conclusions were drawn, from the other tracts visited, as follows :

Taggart Paper Co.'s tract, near Otter Lake ; cuttings of various years between 1905 and 1910 :

Whitney Preserve, 9 year-old lopping and recent lopping ; also results of fire of May 20, 1911, in lopping of 1909, and of fire in same year in unlopped cutting of 1907 ;

P. X. Blake tract, near Joe Indian Pond, lopping of 1911 ; also unlopped cutting of 1905 on adjoining land ;

Recent loppings on Brandreth Preserve and tract of Santa Clara Lumber Company, not specifically noted above.

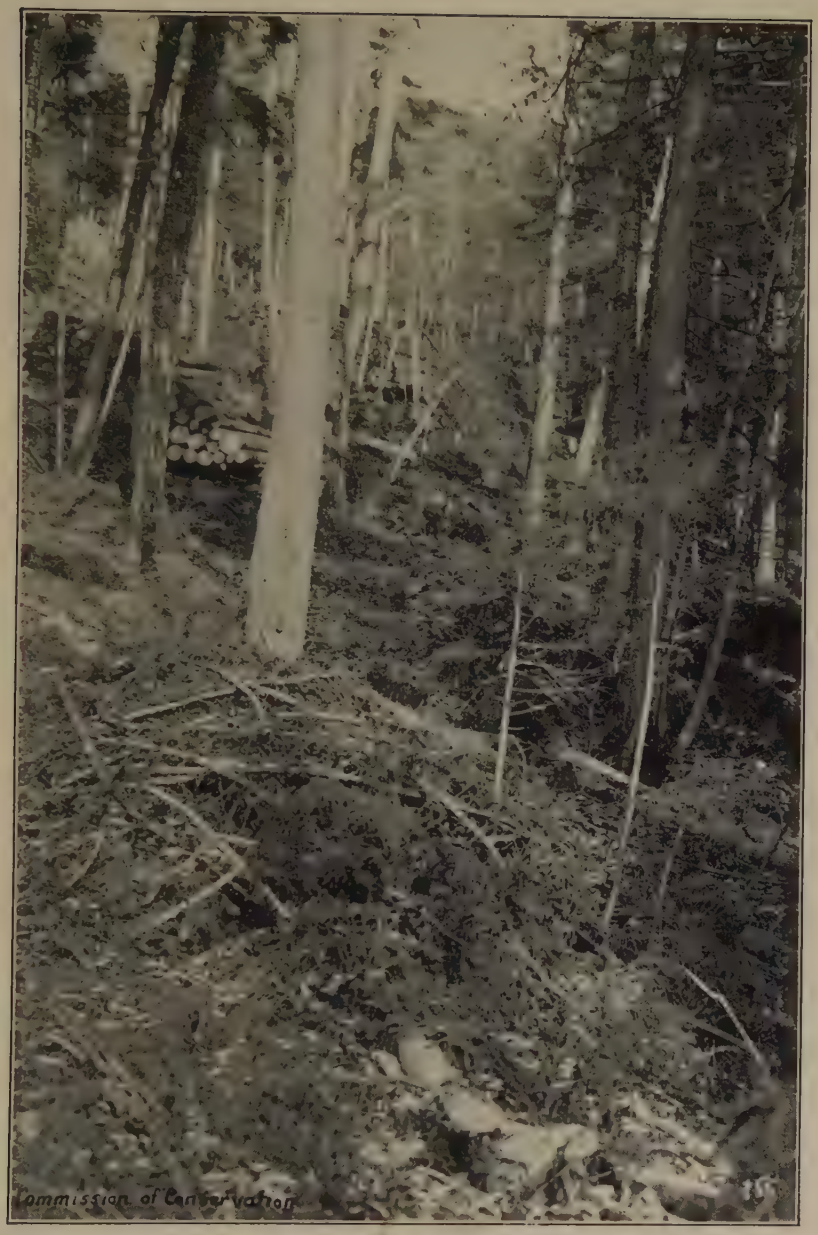
Conclusions.—Conditions vary so widely, as already indicated, that it is somewhat unsafe to make any definite statement as to the rapidity with which lopped and unlopped tops will decay. In a general way, however, it may be stated, that, in the spruce region of the Adirondacks, tops properly lopped and on the ground will practically disappear by decay in from 6 to 12 years, while unlopped tops require from 12 to 30 years. The conditions which influence this process have been quite fully discussed above. Under similar conditions, unlopped tops will require not less than twice as much time to decay as lopped tops, and it is probable that the ratio is more nearly three to one, assuming a reasonable degree of efficiency in getting the lopped material on the ground. For a rough average, in the Adirondacks it may be estimated that decay of lopped tops on a pulp operation will be practically complete in 7 years and the period of most extreme fire danger will be over in three years, due to the earlier disappearance of the leaves and fine branches and

the absorption of moisture by the balance of the material, bringing about partial decay. In unlopped tops, possibly an average of 18 years would be required for decay, while the period of extreme fire danger would extend through not less than half this period instead of being limited to about 3 years as in the case of lopped tops. In a lumbering operation, where only saw logs are removed, the time required for decay in lopped tops may be averaged at 8 years and for unlopped tops at about 25 years. These statements must be regarded as only the roughest kind of approximations, intended merely to give some idea of the relative rate of decay under different average conditions. There was not sufficient opportunity to check all these figures with field observations, and the subject should be investigated further.

The striking point in connection with the efficiency of top-lopping is the fact that the period of extreme danger is concentrated from 8 or 10 years to approximately 3 years, and that decay is practically complete in 7 or 8 years, with only a moderate fire danger after the first three years, instead of having the period of decay doubled or tripled with a serious fire danger covering at least the first half or two-thirds of the total period required for decay.

The margin of difference is of course greatest on a lumbering operation and decreases with the degree of utilization into the top. As previously noted, on a present-day pulpwood operation, the amount of brush necessarily lopped from the merchantable portion of the stick may be as much as 90 per cent. of the total amount of brush originally on the tree. It is self-evident that decay will on the average proceed much more rapidly, and the fire danger will be much less serious after a few years, where 75 to 90 per cent. of the brush is lopped, as on a modern pulpwood operation, than it will in the case of an old-time lumbering operation, where the percentage of unlopped material may closely correspond to these figures. Any increase in the percentage of brush lopped, whether by closer utilization or through observance of law, will inevitably increase the average rapidity of decay and will thus decrease the fire danger to that extent.

Since the fire danger due to slash is in direct proportion to the amount of brush, the above conclusions may be stated in another way. In an ordinary lumbering operation, the lopping of tops will reduce the period of decay from 25 years to 8 years on 75 per cent to 85 per cent of the debris, while the period of most extreme fire danger will be decreased from 10 years to 3 years ; this statement assumes that the lower branches, comprising 15 to 25 per cent. of the debris, would be lopped in any event as a part of the operation. In a pulpwood operation, lopping will reduce the period of decay from 15 years to 7 years, on



RECENT CUTTING ON SANTA CLARA LUMBER CO.'S TRACT, ADIRONDACK PRESERVE

Lopped pile in the foreground. Skidways of pulp wood in the background. Note also how the forest has been opened up. Hardwood, hemlock, cedar and small spruce remain.

10 per cent to 25 per cent of the debris, and the period of most extreme fire danger will be decreased from 7 to 3 years. As before, these figures must be regarded as merely broad generalizations, subject to great variation on account of difference in local conditions, and to revision following more exhaustive investigations.

The prevention of fire is much more important after the young growth is established, and has secured a good start, than it is during the first three or four years after the completion of the operation, since, in the former case, the owner has at stake a far greater investment, which should be regarded as accumulated interest upon the capitalized productive value of the land. The larger the investment the more should the owner desire to secure protection and the more willing should he be to pay a moderate insurance premium, in the form of slightly increased operating expenses, to secure such protection.

Lopping as Insurance.—A large pulp concern in the Adirondacks was offered insurance by a commercial company at 2 per cent of the value of its timberland per annum. This company cuts 80,000 standards per year. At 5 cents per standard, the cost of top-lopping is $4,000 or one-fourth of one per cent. on a total timber-land valuation of $1,600,000 in the Adirondacks. Taking into consideration fire losses, amount spent for lopping tops, maintaining patrol, constructing telephone lines, etc., the cost of fire protection is still under one-half of one per cent. This company therefore considered the protection of its own lands, as above, much better business policy than carrying ordinary commercial insurance.

Holding for Successive Cuttings.—The fact that private owners can and do figure on holding forest lands for successive cuttings, is well illustrated in the spruce region of the Adirondacks. In one case a tract was examined, which was cut over 50, 30, and 19 years ago, and can now be cut over a fourth time. The amount of pulpwood now available for cutting will approximate 8 cords to the acre.

The earlier cuttings were, of course, to a diameter limit, and the young growth just under merchantable size had full opportunity to develop. The cutting on a present-day pulp operation is much closer, and the time between cuttings must be correspondingly longer.

Remaining Sources of Fire Danger.—In connection with the attitude of operators and land owners, it may be noted that a great deal of slash was observed remaining from old cuttings, which, of course, is not affected by the existing law. There is also much fire danger from windfalls in old cutting areas, as well as from old burns, where the danger of recurring fires is great until all inflammable material shall have

been destroyed in this way, or by the process of decay. These sources of danger are offset only by the State system of patrol and lookout stations. The conditions on the lands owned by the State, which comprise approximately one-third of the so-called Adirondack Preserve, are also very unsatisfactory from the standpoint of fire prevention, since, under the State constitution, no cutting of any kind can be done. The declaration is made that these lands must forever remain as wild lands, and not even fire-killed timber can be removed for any purpose, to say nothing of over-mature green timber.

A strong effort is being made to secure a modification of this provision, so that the practice of forestry may be made possible on State lands, thus decreasing the fire danger, and securing a handsome revenue to the State to offset the cost of administration and protection, and at the same time increasing the character and value of the forest from a long-time point of view. It is perhaps not surprising, that, so long as the State retains its present non-progressive attitude toward the use and development of its own lands, the holders of privately-owned lands should object to bearing what they consider more than their fair share of the burden of fire protection. Sufficient allowance is not made by many for the direct benefit of top-lopping to timber owners in the form of decreased fire danger, and for the system of patrol which the State is maintaining in the Adirondacks at its own expense, for the protection of privately-owned, as well as of State lands. The expense incurred by the State in this connection is in excess of $100,000 per annum.

(1-b) Fire Control

There has been much discussion in connection with the relative difficulty of fighting fire in lopped and unlopped tops. Most of the opinions expressed were by men who had had no experience in fighting fires in lopped tops, and thus had only theory as a basis for argument on this feature of the situation.

Fire Fighting.—The forest rangers employed by the State for fire-patrol work testified for the most part, that fires in lopped tops can be more easily controlled than fires in unlopped tops. In the latter case, branches and fine, inflammable material will be standing several feet above the ground, so that in case of fire in a dry time, burning bark, twigs, and small branches may be carried forward by even a light wind. If the weather is sufficiently dry with a strong wind blowing, fire will travel in a sheet of flame, fed largely by the inflammable material standing above the ground. At the worst, a crown fire ensues, with complete destruction of the forest. Where tops are lopped, the debris is on or nearer the ground, so there is less chance for the fire to sweep ahead, and less likelihood of a crown fire, and men are able to get closer

to the fire, for the purpose of fighting it. It seems probable, also, that other conditions being equal, a fire in unlopped tops will spread faster than one where tops have been lopped, for the above reasons.

Construction of Fire Lines.—The relative ease of constructing fire lines was much debated. In this connection, as also with regard to other points discussed, a clear distinction must be made between lumbering and pulp operations. It does not seem possible that anyone could seriously dispute that fire-line construction in an unlopped lumbering slash is much more difficult than in a lopped slash, owing to the large tops, their tangled position, and the resulting large amount of chopping necessary in order to clear a line. There is, however, a certain amount of reason in the contention of the opponents of the law, that on a pulp operation the tops are so small that they can very readily be thrown aside by one man, and that this work can be done more rapidly and more satisfactorily than in lopped tops, where so many more individual pieces have to be handled. On the other hand, the evidence of the forest rangers, who were the only men with actual experience in this particular work in lopped tops, was that fire-line construction was easier in lopped tops. It is, however, undoubtedly true, that the margin of difference on this point would be relatively small, in case of a pulp operation, where there is a close utilization of material in the top, so that very few tops would be left on the ground too heavy for a man to drag aside. The danger of a fire getting across the fire-line would, it is believed, certainly be greater in unlopped tops.

Intensity of Fires.—It is argued that fires in lopped tops are hotter, on account of more of the debris being piled, and are thus more difficult to contend with. The point was made that a camper piles his material together in order to get a fire hot enough for cooking or warmth, instead of scattering the sticks. This is of course true, but, on the other hand, the camper in the first place gathers sticks for his camp-fire, not from old piles of brush, but from the dead lower limbs on standing trees, or from material corresponding to unlopped tops on the ground. Even in a rain this class of material can be utilized to start a fire, since it is almost invariably thoroughly dry inside as a result of long exposure to sun and wind. It is equally true, that, if material for a large camp-fire were so gathered, and were arranged in a pile ready for burning, but not ignited, it would in a relatively short time absorb moisture from the ground, besides retaining a larger percentage of moisture from rain and snow, so that a camper a year or two later desiring to build a camp fire would choose, not the material in the old pile, but material newly collected from individual dry branches, the same as the original source of material for the first pile.

However, during the two or three years after cutting, while the piles are settling toward the ground and the brush is absorbing moisture, it is probable that fires in lopped tops will be somewhat hotter than in unlopped tops. The difference can easily be exaggerated, however, in a pulp operation, where the top-lopping law, as already explained, affects only 10 per cent to 25 per cent of the total amount of brush.

In this connection, it should be noted, that, if a fire does occur in lopped tops, a cleaner burn is probable, thus materially decreasing the danger of a second or recurring fires. The material, being piled to a greater extent, will be more likely to be consumed than in unlopped tops, where a larger percentage of the branches stand out singly, so that the fire is likely to run over them without consuming them entirely. Bearing on the latter point is the argument by opponents of the law, that a fire in unlopped tops will run under the top without burning it, while in lopped tops the piled condition of the debris will tend to a much harder burn, causing greater damage to soil and to any living trees, old or young. The effect on soil, reproduction and old trees will be considered under later headings, but it may be noted here, that such observations as it was practicable to make, indicated that a fire in unlopped tops, will,as a matter of fact, run over the surface of the branches, consuming the smaller ones, and scorching and blackening the larger ones so that they will still constitute nearly as bad a fire-trap as before the first fire. Second or recurring fires are disastrous, since they generally destroy any seed trees or young growth escaping or following the first fire, thus rendering hopeless the question of restocking of valuable species except by planting.

(2) Effect on Future Forest

This involves consideration of the effect of top-lopping on (*a*) existing and future reproduction ; (*b*) soil.

(2-a) Effect on Existing and Future Reproduction

Opponents of the law claim that top-lopping tends to smother existing reproduction, and to prevent the establishment of a new growth on account of the larger amount of debris on the ground or in piles. We may here note the evident inconsistency of this point with the argument previously discussed under (1-a) that top-lopping does not tend to bring materially more debris either in contact with the ground or in piles, and thus does not facilitate decay.

In connection with the effect of top-lopping on reproduction, it must be borne in mind that nearly all operations in the Adirondacks are for pulp, and that three-fourths to nine-tenths of the brush will in any event be lopped in connection with getting out the pulp wood.

Where the cutting is heavy, it is necessary for the brush to be piled to a considerable extent, in order to make room for the skidding operations. The piling of the additional one-tenth to one-fourth of the brush, resulting from the lopping of tops, can have no very noticeable effect upon smothering existing reproduction, or upon keeping out new growth. Under any ordinary conditions the piles of brush can not cover more than 3 per cent to 15 per cent of the ground. This is not enough to interfere seriously with either existing or future reproduction. Conditions in the edges of brush piles are very favorable to both classes of young growth, and piles are seldom so large that a normal crown cover will not result from the growing together of the tops of trees around the edges of the piles, as the trees approach maturity.

Where the cutting is light, so that piling is not necessary, the lopping of the relatively small branches remaining on the top, after the pulp wood has been taken out, will make so thin a covering as they lie on the ground, that they cannot possibly have any material effect in keeping out new reproduction or in smothering any young growth which may chance to be on the ground. In fact, the presence of brush on the ground will facilitate reproduction, if the covering be not too thick. It is well known that spruce requires a moist seed-bed, and the presence of a light or moderate covering of brush, certainly assists in retaining the moisture of the soil.

In case of very heavy cuttings, it is undoubtedly true that the brush may be so thick as to interfere with reproduction, but, in this case, the proper remedy is the burning of at least the larger piles of brush, rather than the discontinuance of top-lopping. As noted, the margin of difference is too small in a pulp operation to be very material from the point of view of reproduction. In a lumbering operation, the margin would be very much greater, but here the extreme fire danger incident to unlopped slash prohibits the abandonment of top-lopping.

The argument has also been advanced that top-lopping tends to hotter fires, and therefore to a greater destruction of existing reproduction. While it may be admitted that fires in lopped tops may be somewhat hotter, as already stated, during the first two or three years after cutting, the reverse will be the case after that time ; and, in any event, the difference can not be very material as to reproduction, since usually even the lightest surface fire will kill all small growth.

It is a matter of common observation that spruce seedlings are most frequently found on old rotten logs. In some cases straight rows of spruce seedlings were found, where the seeds had sprouted in the moss on the tops of rotting logs, which later decayed entirely, carrying the root systems to the ground, thus enabling the small trees to firmly

establish themselves on a permanent basis. From this point of view it may be argued that the lopping of tops facilitates natural reproduction, since the lopped stems of trees will unquestionably decay and acquire a covering of moss on the ground, thus forming a suitable seed bed for spruce seedlings, much more rapidly than would be the case were the tops not lopped. In the latter event, the stem of the unlopped top will remain in the air for many years, until the lower branches decay sufficiently to allow the stem to fall to the ground, after which the process of rotting will set in rapidly and a cover of moss will be formed.

Too much attention can not be given the question of reproduction, since, in the long run, the true test of any system of forest management will be the extent to which the forest is re-established on cut-over areas. It must, however, at the same time be recognized, that the fundamental requisite to this end is protection from fire. Unless this is secured, all other measures looking to the re-establishment of the forest are useless. The perpetuation of the forest through wise use, constitutes the distinguishing characteristic of the forester, as contrasted with the old-time lumberman.

(2-b) Effect on Soil

The effect of fire upon the soil is chiefly important because of its bearing upon the re-establishment of the forest. Soil fires in the Adirondacks either result in a material change in the composition of the forest, or render the land incapable of producing anything of value for an indefinite time, through destruction of the elements of fertility and through erosion of the remaining mineral soil. Planting is generally necessary, to secure a forest cover of valuable species on burns, especially where fires have been successive, thus destroying seed trees.

Opponents of the top-lopping law argue that top-lopping tends to harder burns, and therefore to greater soil destruction in case a fire once gets started. This subject has already been discussed in part under previous headings, and the conclusion reached that lopping tends toward a cleaner burn, and that a fire will very probably be somewhat hotter if it occurs during the first two or three years after the cutting. It does not, however, necessarily follow that the danger of soil destruction is sufficiently greater with tops lopped to furnish any real argument against the law. If weather conditions are very dry and a fire gets started, it will destroy practically everything, entirely regardless of whether tops are lopped or not. The tremendous areas of unlopped slash burned over in the great fires of 1903 and 1908 in the Adirondacks illustrate this sufficiently well. In such a time, not only the brush but the thick layer of decayed vegetation known as duff will be as dry as tinder, and any kind of a fire will develop into a soil fire. Unless the

brush has previously been burned, it will carry a fire and ignite the duff in extremely dry weather, whether tops have been lopped or not.

Observations were made on the burn of May 20, 1911, near Sperry Pond, in the Whitney Preserve, where tops were lopped in 1909. The conditions here indicated, that, in case of spring fires, the bottoms of the piles of lopped tops remain in a moist condition much longer than where tops have not been lopped. Fine branches were found unburned at the bottom of what had been a pile of lopped tops, indicating that the moisture from snow and rain had been retained far beyond the time when similar material exposed to sun and wind would have become thoroughly inflammable.

It seems fair, therefore, to conclude that a spring fire in lopped tops may not injure the soil as much as one in unlopped tops, where there has been a better opportunity for the drying action of sun and wind. Later in the season the situation might be reversed, but, as noted, by the time the piles of lopped tops have become thoroughly dry, as a result of extreme weather conditions, the duff will have become sufficiently dry to burn readily, regardless of the intensity of the surface fire.

(3) Effect on Remaining old Forest

The considerations already discussed with regard to the relative intensity of fires in lopped and unlopped tops, are also the controlling factors here. It is possible that a fire occurring in lopped tops within two or three years after a lumbering operation will destroy more of the remaining old trees than would be the case in unlopped tops. The controlling factor would be the relative amount of inflammable debris piled against or near the standing timber. In a pulp operation, however, it is believed there would be little if any difference within three years, since from 75 to 90 per cent. of the branches will be lopped anyway, and a fire in these would be hot enough to kill any green timber standing near the piles, regardless of whether the remaining 10 to 25 per cent. were lopped or not. After the first three years, on the other hand, the danger on lopped tops should grow rapidly less, on account of decay and the greater degree of moisture where material is on the ground or in piles. After 7 or 8 years, the slash danger will have practically disappeared in lopped tops, while it will still be very serious in an unlopped slashing. The percentage of brush resisting decay, on account of being supported above the ground, will be so small and so widely distributed in a lopped cutting, that the menace from this source will not be serious, and the situation could readily be controlled in case a fire should occur.

(4) Effect on the Cost of the Operation

The really fundamental objections to the top-lopping law on the part of most lumbermen who are opposed to it, are, the additional cost, the annoyance involved through inspections by State officers, and the resulting interference with the methods of handling woods work. The claim is made that the beneficial results are not commensurate with the cost. As previously indicated, some operators claim that top-lopping is a distinct detriment, and say that they would, if they had the option, prefer to pay the extra cost to the State and be relieved of the necessity of lopping. Others argue that much more efficient protection from fire could be secured through the expenditure of the same amount of money in some other way, as on patrol. The essence of the problem is, then, whether the benefits of top-lopping are worth what it costs.

Estimates of Cost

Claims of operators, as to the added cost imposed by lopping, vary widely, ranging from 5 cents to 50 cents per cord. Conditions also undoubtedly vary widely, so that no positive statement will hold good, except in a very general way.

The preponderance of evidence seems to indicate, that, under average conditions, the additional cost imposed by the top-lopping law is from 10 to 15 cents for each cord of pulpwood taken out. Fifteen cents per cord is the amount with which the Santa Clara Lumber Company credits their camps, on account of additional work required in lopping tops. The Empire State Forest Products Association says it costs 5 to 10 cents per cord to lop tops. Finch, Pruyn and Company, large pulp operators in the Adirondacks, estimate the added cost at 5 cents per standard, or 15 cents per cord. Graves states in "Principles of Handling Woodlands," that the cost of lopping the tops of spruce on the early operations in the Adirondacks was 12 cents per thousand feet of lumber cut. This would correspond to approximately 6 cents per cord. Here, however, it must be considered that the operation was for lumber only, and that, consequently, only the larger trees were cut. As a result, the amount of brush per unit of measurement was low, whereas on a pulp operation the trees will average much smaller and the amount of brush per unit of measurement will be relatively high.

These figures, aside from the one quoted from Graves, cover the cost of lopping small trees which cannot be utilized, but which must be cut and lopped in connection with road work.

They cover also the cost of lopping trees felled but found to be culls, from which little or no utilization is possible, but which must neverthe-

UNLOPPED TOP 21 YEARS AFTER CUTTING FOR LUMBER

Old operation of Santa Clara Lumber Co., on what later became the Cornell College Tract, Adirondack Preserve. Note extent to which decay has been resisted. The top consisting principally of sapwood, has nearly rotted away.

UNLOPPED TOP, 14 YEARS AFTER LUMBERING, SANTA CLARA LUMBER CO. TRACT, ADIRONDACK PRESERVE

Note extent to which this top has resisted decay.

less be lopped, under the law. Where the number of culls and of small trees cut out to make room for roads is very large, an additional expense is imposed for lopping, which may augment the total cost for all top-lopping work up to about 25 cents per cord. This, however, is the extreme and not the average case.

The late Mr. E. G. Joly de Lotbiniere reported at the Quebec Convention of the Canadian Forestry Association with regard to experiments conducted by him, as to the cost of brush disposal in the spruce region of Eastern Canada. The result of the experiments indicate that it cost approximately $1.25 per M. to burn the brush. This involved the processes of lopping, piling and burning. Lopping and piling alone cost one half the above figure or 62c. per M.; but lopping and scattering the brush cost 31c. per M. The latter figure would correspond closely to 15c. per cord for pulp wood. However, where the pulp is cut to a diameter limit of 4 or 5 inches in the top, and where no extra trouble is taken to scatter the brush the cost should be materially lower.

It has been demonstrated by the U. S. Forest Service that the cost of brush disposal can be very materially decreased after one or two years' experience. This is due to the fact that brush disposal becomes a recognized part of the operation, the men becoming more familiar with the work, and the most satisfactory methods being developed through experience. In this way the cost of burning brush, after lopping and piling, has been reduced from an initial figure sometimes as great as $1.00 per M. to as little as 10 cents per M. The average cost of piling and burning the brush, on many operations in the National Forests in the Western States, is approximately 35 cents per M. This corresponds to approximately 18 cents per cord.

Closer Utilization.—The enforced lopping of tops by the state law, has, on many tracts, resulted in a much closer degree of utilization through the removal from the woods of much pulp material from the tops that would otherwise be left unused. Some operators claim that the additional revenue from this source alone will offset the cost of top-lopping. Close utilization is of course possible and should be practised as a business measure, whether tops are lopped or not. The more progressive concerns have voluntarily made much progress along this line.

In connection with the above, the following statement is of interest, quoted from a report dated December 20, 1909, to the Superintendent of State Forests, by John W. Stephen, then State Forester of New York:

> "The amount of wood saved varies greatly with the nature of the operation, and there are various opinions as to the saving made in guttering and skidding. One operator, estimating the

cost of lopping at an average of two and one-half cents per standard, remarks, that to offset this, he was able to run a skidding crew about one man less to each team, and also occasionally got a log that would otherwise be left. The actual additional cost he did not think would be over five cents per thousand feet board measure. He believed, that, when four-foot pulp-wood was taken, the cost of lopping would be entirely made up in the extra amount of wood he would get. In addition, his forest was left in much better condition than under the old plan, and he believes that it decreases materially the danger from forest fires.

"A remarkable saving in connection with lopping was made by another operator who had been cutting spruce for saw logs, taking the timber out with what was considered good economy. He left the lopping until after the logs were removed, and then went through, lopping the branches and taking the timber out of the tops for pulpwood. In this operation, with a force of eight men and a horse employed six days, ninety-seven cords of pulpwood were obtained that would bring him $7 per cord delivered at the mill. This is an average of two cords per man per day, making a very profitable operation."

Skidding.—Some operators claim while others deny, that the lopping of tops will materially facilitate skidding operations, on account of the brush being less in the way and easier handled when necessary. Some of the friends of the law state that this advantage offsets at least a considerable part of the extra cost imposed by the law.

Peeling in the Woods.—Some operators make a practice of peeling the stick of pulpwood as a part of the woods operation, instead of leaving it to be rossed at the mill. Peeled pulpwood will dry out with relatively greater rapidity and is therefore lighter and more can be hauled at a load than where peeling is not done. One operator claims that the saving in this respect is sufficient to pay for the cost of peeling. Peeling slightly decreases the bulk, so that there is a loss of about one cord in twelve. This, however, is offset by the higher value at the mill.

Three-Inch Diameter Limit for Lopping

If pulp is peeled in the woods, there is no reason why it cannot be utilized to a diameter limit of two or three inches in the top. If this were generally practicable, it is believed that the problem of top-lopping would be practically solved in connection with the high degree of utilization, since it would seem unnecessary to insist upon lopping any tops below a diameter of three inches. It is claimed however, by operators, that, where the pulpwood must be driven down rocky streams, the cost of handling in the woods, and the loss in driving, will offset the revenue derived from the sale of the small sticks, so that it does not pay to cut to a diameter limit of less than 4 inches. It is also claimed by some operators, that the smaller sticks merely fill up the chinks in the

piles of the larger poles, so that there is no material increase in the number of cords for which payment is received on account of turning in the smaller sticks. This objection may hold good to a limited extent but it is not believed to be generally applicable, since it is well known that there is a larger loss in air space from piled small sticks than from large ones. Where the operator is also the owner and operator of a pulp mill this objection would entirely disappear since the small sticks will unquestionably furnish a large amount of valuable pulp wood. It is however, essential that at least the small sticks be peeled in the woods, since poles cannot be rossed at the mill below 4 inches in diameter.

The utilization of short lengths of pulpwood, in addition to the present practice of taking out only poles 13 feet or more in length, would result in saving a great deal of material that now goes to waste, and would facilitate cutting to a smaller diameter limit in the top than is now practicable. This would assist very materially in solving the problem along the lines discussed in the preceding paragraph. The utilization of short lengths of lumber has been found entirely practicable, and is in effect in Canada, though unfortunately in the United States the strong attempt to secure adoption by retailers failed of success. It is probable, however, that under present conditions, not much is to be looked for along this line in connection with pulpwood, on account of the inconvenience in dealing with the odd lengths prior to their reaching the pulp mill.

It should be understood that the adoption of the so-called 3-inch diameter limit in connection with top-lopping operations is suggested only as a possible measure of relief to meet the claim of excessive cost by the operators. It is admittedly not quite as efficient in promoting decay as the lopping of all branches, but it may certainly be maintained with a good show of reason that the results from lopping tops below 3 inches are not worth the added cost to the private owner.

One disadvantage of a 3-inch diameter limit for top-lopping is the fact that the small saplings cut out in connection with road work would not be lopped, but would be thrown in wind-rows along the roadsides, thus somewhat increasing the fire danger, and decreasing the value of roads and trails as potential fire-lines.

It may be argued, that, because some operators are now utilizing material almost, or quite down to, 3 inches in the top, laws or regulations requiring the lopping of tops are really unnecessary. It should, however, be remembered here that very many pulp operations do not even approach a 3-inch utilization, and that it is still necessary to provide for control of the situation on lumbering operations, where close

utilization is impossible, unless combined with a pulp operation. It will be seen that the adoption of a 3-inch diameter limit for lopping on pulp operations would place a distinct premium on close utilization.

The difficulty of administering the top-lopping law, under a 2 or 3 inch diameter limit, introduces the matter of judgment of the men in the woods. Some of the pulp operators state that they would rather see the law remain as it is, than have this modification made. In some cases the reason is given frankly, that the law in its present form will the more quickly defeat itself through the infliction of apparent hardship upon the lumbering interests, thus resulting in the early repeal of the law. In others cases, lumbermen, who are either fully in sympathy with the law, or believe that it has not yet had sufficient time for fair trial, claim that the introduction of a requirement for top-lopping only above a stated diameter limit would result in more trouble and annoyance and would, in the end, be a greater hardship than the enforcement of the present law, which requires the lopping of all branches from the main stem without regard to size. Still others favor the change unqualifiedly.

The modification of the law to provide for top-lopping above a three-inch diameter limit, would relieve the pulpwood operators of probably not less than half, and in some cases two-thirds or more of the additional cost now imposed upon them by the law. The greatest relief would be in connection with the smaller trees brushed out in order to make way for road construction. The branches on small trees below a 3-inch diameter limit, as well as the branches on the tops of the larger trees below the same limit, are much smaller, have a greater percentage of sapwood, and will, accordingly, decay much more rapidly, even without lopping, than the old branches lopped from the lower portion of the tree cut for pulp or lumber. This process is facilitated by the heavy snow fall which will force to the ground within a few years the relatively small branches comprising the sapling or top below a 3-inch diameter limit. Undoubtedly the lopping of all branches below a 3-inch diameter limit will facilitate more rapid decay ; however, on the other hand, this requirement involves a material extra expense to the operator ; this does not seem to be justifiable in view of the relatively slight decrease in the fire danger which can take place before the decay of the larger branches from the lower portion of the tree.

This question would be of importance in Canada, should laws or regulations be proposed, requiring the lopping of tops. In general, it is believed, that, where lopping is considered necessary, such a law or regulation could as a matter of fact be administered with less friction and dissatisfaction under a 3-inch diameter limit than where all tops are required to be lopped, regardless of size.

WINDFALL ON CUTTING TO 10 IN. DIAMETER LIMIT, ADIRONDACK PRESERVE

State law requires that no cutting shall be done below 10 in. diameter limit where land purchased subject to the right of the owner to remove timber. Tops not required to be lopped. Shows evil of rigid diameter limit cutting in spruce. Fire danger extreme. Neutralizes good effects of lopping on later operations. Cutting two years old.

It is essential to the enforcement of any law, that the people concerned should fully understand its purpose, and sympathize with the object sought to be obtained. A law requiring lopping only above a 3-inch diameter limit would undoubtedly appeal to the general public and to the lumbermen, as being more reasonable than the present requirement for the lopping of all tops without regard to size. The details of administration could readily be handled through the assignment of a sufficient number of rangers to keep constantly in touch with the operators in the woods and assist them in the execution of the law without unnecessary resort to the infliction of penalties.

Shifting the Cost to the Consumer.—Since lumbermen and pulpwood operators in the Adirondacks are affected alike by the top-lopping law, it might be maintained, that, in the long run, the extra cost of lopping would naturally be regarded as a necessary element of total cost, and would appear in the form of higher prices to the saw or pulp mills, thus shifting the burden to the consumer. This, however, is met by the argument that the prices of pulpwood are determined not so much by local operating costs, as by the competition of outside sources of supply, particularly the Canadian forests, where top-lopping is not required. It is also pointed out, that values of pulpwood at the mill are partially determined in a general way by the market prices of paper, and that these prices are regulated by competition throughout the country, so that a local matter like the New York top-lopping law could have but little if any effect in bringing about such a readjustment as to shift the cost of lopping to the ultimate consumer. It appears, therefore, that for the present at least, the bulk of the extra cost of lopping must be borne by the land owner.

Protective Measures on Government Lands.—Where the Government is a land owner, whether State, Provincial or Federal, the individual can have no reasonable complaint as to the imposition of conditions looking toward the protection and perpetuation of the forest. This is true since he necessarily takes these conditions into consideration in fixing the amount of his tender or bid for the privilege of cutting. In case of renewal of a license, the conditions, whether new or old, are again considered fully, and the prices are adjusted to correspond, so that the burden of the protective measures falls upon the Government, where it belongs, since it is chiefly interested in maintaining the permanence of the forest as such.

Elasticity in Requirements Desirable.—It will be noted that the top-lopping law in the Adirondacks provides a rigid and unyielding system for minimizing the fire danger due to cutting operations. It might, with much apparent justice, be argued, that, under some cir-

cumstances, other measures would afford a reasonable amount of protection, such as the construction of fire lines around cutting areas, combined with efficient patrol. However, no administrative officer has any discretionary authority in determining what steps are necessary to meet the ever-changing conditions. It seems fair to assume that the rigidity of the system is at least partially responsible for the general complaint that is now made against the law.

While the fire danger in some portions of eastern Canada is much less than in the Adirondacks, in other portions the danger is greater, and it is not believed that any general and non-elastic system of brush-disposal would be advisable. On the contrary, the requirements to be imposed should closely fit local conditions in every case. This can best be brought about by having competent administrative officials with full discretionary authority to settle each case on its own merits. The exercise of discretionary administrative authority is distinctly to the advantage of the operator, as well as of the land-owner, since in this way the minimum rather than the maximum of requirements will be imposed without sacrificing efficiency of protection. Where a rigid system is imposed, the requirements must necessarily fit the extreme rather than the average or the minimum case.

In this connection, the experience of Minnesota, in changing from a rigid to an elastic system of enforced brush-disposal, is of great interest. A brief statement of this situation is included elsewhere in this report.*

* See page 54 *et seq.*

Part IV

The Use of Oil as Locomotive Fuel*

From a Fire-Protective Point of View

In many lines of industry, oil fuel is rapidly displacing coal. The change that has taken place in this respect in the Western United States within the past five years is remarkable. In Canada, a notable movement towards oil fuel has been going on within the past two years, principally in British Columbia.

In this connection, the following is quoted from a recent article by Mr. H. Foster Bain :†

"The dominant factor in the Pacific coast fuel situation is no longer coal but oil, and of this, in 1911, California produced 77,224,359 net barrels. Not all was shipped, and by no means all was used for fuel, but it is estimated that 40,000,000 to 50,000,000 bbl. each year are now burned for fuel, replacing 11,000,000 to 12,000,000 tons of coal. Fuel oil is delivered at tidewater from Alaska to Peru at prices that give it a marked advantage over coal, without taking into account the incidental advantages of cleanliness, lower cost of handling, and decreased labour cost in the fire room. Fuel oil is delivered on the Pacific Coast at 85c. to $1 per bbl., equivalent to a cost of $3 to $3.50 per ton for coal, considering fuel value alone. The surplus above ground, over 40,000,000 bbl., the extent of territory developed, and the ease with which production is increased, give every assurance of continued supply at reasonable price for years to come. As a result, oil has practically replaced coal throughout California, western Arizona, Nevada, and Oregon, and is rapidly gaining a foothold in Alaska, British Columbia, Washington, Mexico, Central and South America. In California, coal is now little used, except for domestic heating and for bunker purposes on certain steamships, that have not yet found it economical to change to oil burners. Practically all the regular coast-wise steamers, save some belonging to the Pacific Coast Steamship Company, which company has its own coal mines, now burn oil. The Alaska Steamship Company, the Canadian Pacific, the Grand Trunk, the Oceanic, the Matson, and other lines have adopted oil. It is especially interesting to note that the Oceanic steamers now being rebuilt at San Francisco, to run between that port and New Zealand, will burn oil. The steamers of the Toyo

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* Liquid fuel is crude petroleum as received from the wells, or the product of crude petroleum, distilled or reduced (Howard Stillman, in Railway Age Gazette, March 15, 1912.)

†Fuel Problems on the Pacific, by H. Foster Bain, Transactions Can. Mining Inst., 1912.

Kisen Kaisha on the trans-Pacific run, originally fitted for burning oil, have been altered to burn coal because of the absence of an oil supply in Japan and difficulties over the tariff, on oil imported into that country. This fact is notable in that it is almost the only instance of a large user of oil going back to coal-burning. The trans-Pacific steamers in general burn coal. The reason for that lies in part in the conservatism of the management, but also in part in the low cost of coal in Japan, low cost of Oriental labour available in the fire rooms, and excess of cargo space which has permitted Pacific Mail boats, for example, to take coal at Nagasaki for the round trip. In general, however, California oil not only dominates the fuel situation on land along the Pacific coast, but is rapidly being substituted for coal on the sea. On land, for transportation and manufacturing, the most important competitor of fuel oil is hydro-electric power. Here the race is between low overhead charges and low operating costs, and at competing centres such as San Francisco, the two are about equal."

Because the greatest supplies of oil fuel are to be found in Southern California, its use on an extensive scale has naturally first taken place along the Pacific coast, where cheap water transportation is available. This tendency has been much strengthened by the fact that coal is relatively scarce and expensive, or of unsatisfactory quality, along the Pacific Coast of the United States.

It has been confidently predicted, that, with the opening of the Panama Canal, oil will become the fuel of the Gulf and Atlantic coast vessels and of the railroads of the Mississippi Basin. The extent to which such use is likely to increase in Eastern and Central Canada is problematical, though a material development in this respect must be anticipated. In the meantime, a long step toward the solution of the problem for Canada and the Atlantic Coast in general, has been taken by the great development of oil supplies in Mexico.

Should a satisfactory source of oil fuel be developed in Canada, so that it could be supplied for a long period, in large quantities and at a low cost, the market would be practically unlimited. In this connection, it must be recognized that the potential sources of oil fuel are very great in the extensive deposits of oil shales in New Brunswick and Nova Scotia, and in the regions around Fort McMurray and Fort McKay on the Athabasca river, Alberta, where enormous deposits of tar sand have been found.

Although the relationship between oil fuel and fire protection along railways is the principal subject of this discussion, it may be of interest first to consider briefly some of the other uses and advantages of this relatively new fuel.

Use of Oil Fuel for Steamships

Oil is being used to a constantly increasing extent as fuel on coast-wise steamships along the Pacific Coast of Canada and the United States. The recent installation of oil-burners on Canadian Pacific and Grand Trunk Pacific steamers out of Vancouver is an illustration. In Eastern Canada, the Richelieu and Ontario Navigation Co. has equipped two steamers with oil-burners.

The rapid increase in the use of oil as fuel for battleships is noteworthy in this connection. One by one the navies of the world have been tentatively and slowly adding oil-driven warships to their fleets. It is said that the British navy has made greater advance in the use of oil fuel than has the navy of any other country, notwithstanding her magnificent resources in coal, which have so long formed the backbone of her naval supremacy.

It has been found that two tons of oil will do the work of three tons of the best coal. This is a tremendous advantage in favour of oil, since it means equal or greater, efficiency with an enormous saving in weight and space. This is of vital importance in a warship, since it means a proportionate increase in cruising range. The development and adoption of internal-combustion engines, of which the Diesel engine is a type, will enormously increase this advantage.

Other general advantages of oil fuel for steamship use are :

(1) Great saving in time and labour in loading with fuel ;

(2) Great reduction in number of men required for handling fuel on board ship ;

(3) Reduced cost of boiler and other repairs ;

(4) Increased cleanliness ;

(5) More complete combustion and therefore greater efficiency of oil fuel.

The following report by G. W. Dickie, published in *The Vancouver Province*, on the comparative costs of coal and oil as fuel on one of the C.P.R. British Columbia Coast Service steamships, is of interest, in view of the number of vessels which have recently been built to consume liquid fuel, or have been changed so that either of the two fuels may be used. The costs of coal and oil for the *Princess Victoria* are given as follows :—*

Coal

	Per Day
100 tons at $4.50	$450.00
9 firemen at $55 a month each	16.50
9 trimmers at $45 a month each	13.50
Food for 18 men	7.56
Total	$487.56

*Canadian Railway and Marine World, April, 1913.

Oil	
344.17 barrels, at 90c	$314.25
6 firemen	11.10
Food for 6 men	2.53
Total	$327.87

Oil Fuel for Donkey Engines

Although no specific statistics have been collected in this connection, it is known that oil is in use to a very considerable extent as fuel for donkey engines used in logging operations in the Western United States and Canada. The primary object in such cases has, as a rule, been the endeavour to reduce the fire danger during the dry season. It was soon found, however, that, in addition to great efficiency in this direction, the use of oil fuel resulted in many cases in a material saving of fuel cost, and in an increased output of logs with less labour. One large logging company claims that by the use of oil during the season of 1912, its log output was increased at least twenty per cent. from the same number of donkeys and men. Two of the factors in bringing about this result were increased steaming capacity of the boilers, and the greater convenience and saving of time due to the abolition of the wood yard. To offset the initial cost of oil installation in donkey engines, is the saving of the cost of the expensive spark arresters necessary when wood is used.

Oil as Locomotive Fuel

The use of oil as locomotive fuel is in general an economic question. Railways must, as a rule, use the cheapest available source of power in moving their trains. The answer to the question is in each case dependent upon the cost and availability of oil fuel in comparison with coal or electricity.

Practically the only exceptions to this are cases where some governmental authority has required the use of oil fuel as a fire preventive measure. An example of this is the order of the Public Service Commission of the State of New York, requiring the use of oil fuel on railroads through the Adirondack Forest Preserve, even though this requirement undoubtedly imposed an additional burden of cost upon the railways, owing to relatively low cost of coal and high cost of oil at points of use. In a number of cases also, railroads have been required by the U. S. Government to use oil fuel, as a condition to the granting of permission for the construction or maintenance of railway lines through National Forests or National Parks.

It is also undoubtedly true, that, in some cases, logging railways have adopted oil fuel in order to minimize fire danger, even where coal

would have been cheaper. It is clear, however, that, in such cases, the use of oil is distinctly economical in the long run, on account of the resultant decrease in cost of fire-fighting, loss of company's property, and amount of damage claims.

The use of wood as locomotive fuel has long since practically disappeared, except on some logging railways. For years coal was used almost exclusively. Recently, however, the use of oil fuel by railways has increased tremendously. The available world supplies of oil appear to be adequate for an almost indefinite expansion of such use, for an indefinite period of time. However, the constantly increasing prices of fuel oil have seriously halted the movement as to use by railways. In some cases, railways are reverting in whole or in part, to the use of coal. Examples of this are portions of the Rock Island, Santa Fe, and Frisco systems, where coal-burners have recently replaced oil-burners on 3,679 miles of line.

As indicating the same tendency abroad, reference is made to a recent dispatch announcing that on account of the increased price of fuel oil, the Australian Government will change its oil-burning locomotives back to coal-burning.

Another announcement, at about the same time, indicating the opposite or onward tendency of the movement in other parts of the world, is to the effect that the installation of oil-burning locomotives is being considered on some of the Government railways in India.

On the other hand, some railways are adopting, or considering the adoption of, electricity for motive power, especially on mountain sections, where water power is naturally abundant, conveniently situated, and cheap, and where the greatly-increased efficiency of such power on heavy grades is particularly valuable from the point of view of efficient and economical operation. The absolute disappearance of fire danger due to locomotive operation, while an incidental benefit of great value, is probably in no case a governing consideration. An illustration along this line is the Chicago, Milwaukee and Puget Sound railway, which is now undertaking the electrification of its line between Harlowton, Montana, and Avery, Idaho, a distance of 440 miles. This portion of the line, together with a large additional mileage, is now using oil as locomotive fuel. It is announced that the work of electrification is to be completed by the middle of 1914. The Canadian Pacific Railway has also announced its intention to electrify its line between Castlegar and Rossland, in Southern British Columbia.

Some of the coal-burning roads, utilize that fuel, wholly or in part, because they have important coal traffic to foster. In some cases, the railway companies own or control their own coal fields, and are thus

more or less committed to the use of coal as fuel, although under other circumstances, oil would, in some cases, be the most logical fuel.

*How Oil Fuel is used in Locomotives.**—The use of oil fuel in an engine is very similar in principle to that of a great torch, the flame from which passes through the flues and thus heats the water in the boiler. The burner, which corresponds to the torch in the above comparison, is situated in the fire-box. The supply of oil is carried in a tank in the tender and is conveyed to the engine by pipes. The oil in the tank is heated by steam pipes from the boiler, so that it will flow easily through the pipe connection to the burner. On the way to the burner it passes through a superheater, which raises the temperature to approximately 200 degrees, so that it is comparatively hot when it mixes with the steam in the burner. The steam forms the atomizing agent and sprays the oil into the fire-box in very minute particles. The oil in this condition burns readily, and makes an intensely hot flame. The oil in itself, however, is sluggish and does not burn readily, it being impossible to light it with a match.

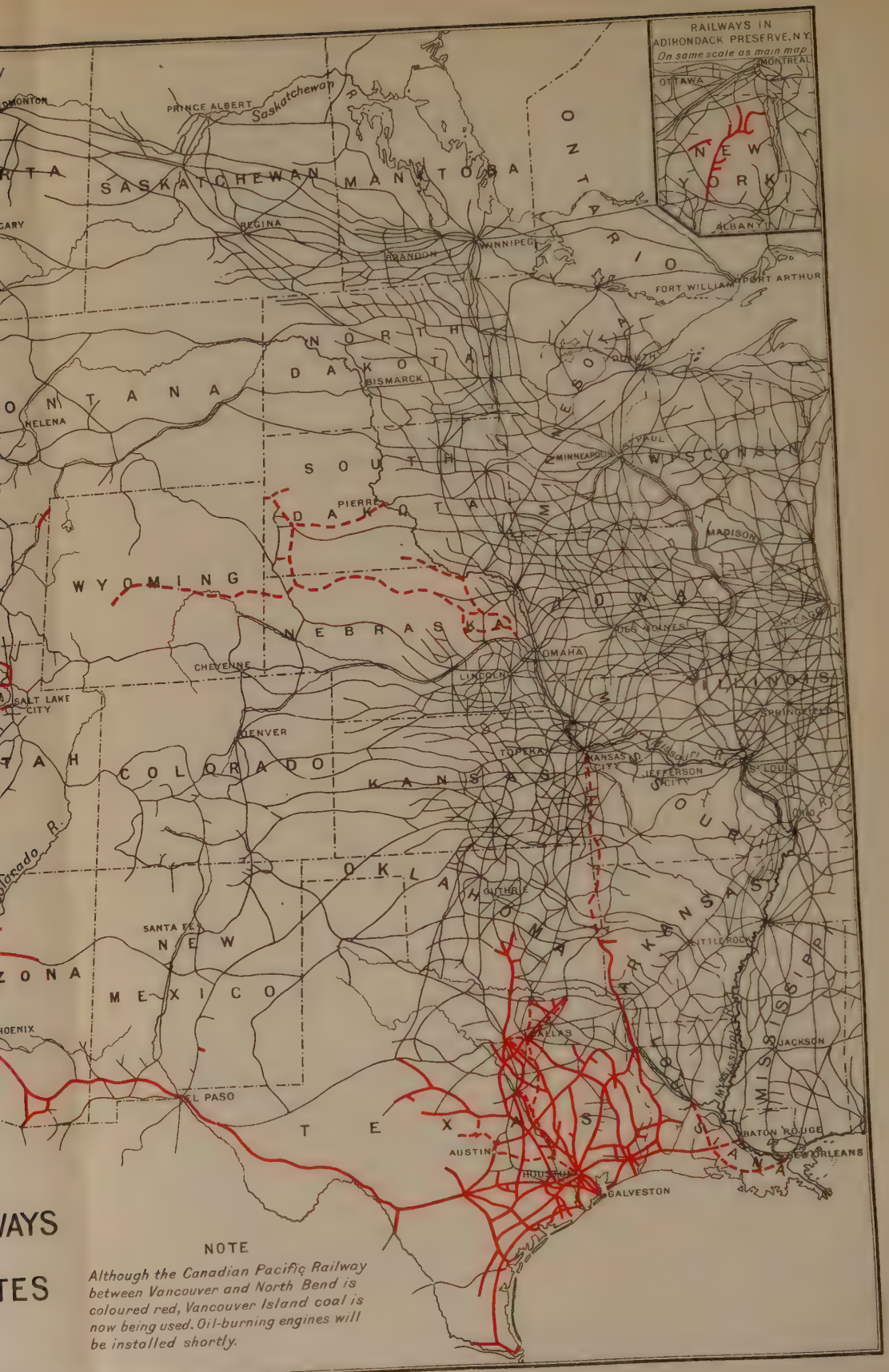
It is necessary to keep the flues clean, as oil deposits a heavy carbon residue. This, however, is very simply and easily done by the use of dry sand. Whenever the engine is wide open and exhausting freely through the stack, so that there is a strong forced draught, a couple of scoops of sand are sprinkled through the opening for that purpose in the fire door. This sand serves to cut the carbon and cleans the full length of the flues, so that they are kept clean with very little work or expense.

Southern Pacific the Leader.—The first locomotive converted from a coal burner to an oil burner, in regular service, was on the Southern Pacific, in November, 1900, and a number of comparative tests proved so satisfactory that, in February, 1901, other engines were converted. In about five years all locomotives on the Southern Pacific in California and on the lines extending to El Paso, Texas, were converted to oil burners.†

The use of oil fuel by railways has steadily increased until, in the early spring of 1913, oil-burning locomotives were operated exclusively upon 20,910 miles of line in the United States, and 587 miles in Canada, and were operated in conjunction with a proportion of coal-burning locomotives upon 4,720 miles additional in the United States. Thus, in the United States and Canada, oil fuel is in exclusive or partial use upon 26,217 miles of railway line. This is exclusive of portions of the Rock Island, Frisco and Santa Fe systems, where, as above noted

* Western Lumberman, June, 1912.

† Railway Age Gazette, March 15, 1912.



NOTE

Although the Canadian Pacific Railway between Vancouver and North Bend is coloured red, Vancouver Island coal is now being used. Oil-burning engines will be installed shortly.

the use of oil-burners had been previously reported, but on which such use has been or is being discontinued.

The Situation in Canada.—In Canada, the Great Northern railway is the pioneer among passenger lines. This line is using oil exclusively on its 115 miles of railway in the Cascade Division. This embraces all lines in the vicinity of the Pacific Coast.

During 1912, the Canadian Pacific railway established oil-burners on its main line between Kamloops and Field, B.C., and on the Arrow and Okanagan branches, making a total of 338 miles. It is now announced that this line will, during 1913, extend the use of oil-burners to cover the main line between North Bend and Vancouver, 129 miles, and the Mission subdivision, 10 miles. When this work is finished, the only portion of the main line of the C.P.R. in British Columbia not using oil fuel will be the portion between the Eastern boundary of the Province (Hector), and Field, 12 miles, and between Kamloops and North Bend, including the Nicola Branch, 168 miles ; total, 180 miles. The oil-burning portion of the line in British Columbia will then comprise 477 miles.

There is reason to believe that eventually oil will be used on all of the main line of the C.P.R. west of Calgary, Alta., except in the long tunnels which are to be constructed through the Rockies. Here, it is understood, electricity is to be the motive power. So far as present plans are concerned, it is understood that District No. 3 of the British Columbia Division will continue to use coal-burners. This includes the Boundary and Kootenay country.

The Esquimalt and Nanaimo Railway has installed oil on its 134 miles of line between Victoria and Alberni, on Vancouver island.

The Grand Trunk Pacific has for some time been investigating the question of oil fuel, but it is understood that no definite conclusion in the matter will be announced until after the completion of the line across British Columbia.

Statistics.—The following table contains the information secured through correspondence between the Secretary of the Commission and the various railways concerned, as to the extent to which oil fuel is used on railways in the United States and Canada. As above noted, these figures do not include logging railways using oil fuel, or the 500 miles on the Rock Island system, 1,118 miles on the Santa Fe system, and 2,061 miles on the Frisco system, on which the use of oil has been, or is being, discontinued.

USE OF OIL FUEL

Name of Railway Line	Oil Used Exclusively (miles)	Oil in Partial Use (miles)
Lines in the United States		
Atchison, Topeka & Santa Fe System	4094	....
Atchison, Topeka & Santa Fe (Coast lines ; exclusive of Albuquerque to Winslow). 1,724.77	.....	....
Grand Canyon Railway..... 64.11	.....	....
Santa Fe, Prescott & Phœnix Ry..... 364.23	.....	....
Gulf, Colorado & Santa Fe Ry..... 1,596.06	.....	....
Texas & Gulf Ry..... 126.66	.....	....
Concho, San Soba & Llano Valley R.R... 61.19	.....	....
Gulf & Interstate Ry..... 71.97	.....	....
Pecos & Northern Texas Ry. (Coleman to Sweetwater)..... 84.60	.....	....
Bellingham & Northern	62	....
Central of Georgia (*a*)	18	....
Chicago & North Western (including Wyoming & N. W. ; and P.R.C. & N.W.)	....	1,461
Chicago, Milwaukee & Puget Sound	885	....
Delaware & Hudson (*b*)	....	83
El Paso & Southwestern	26	....
Frisco System :		
St. Louis, Brownsville & Mexico	510	....
St. Louis, San Francisco & Texas	....	197
Galveston, Houston & Henderson	50	....
Great Northern (*c*)	692	....
Idaho & Washington Northern	151	....
International & Great Northern	996	153
Kansas City Southern	478	398
Las Vegas & Tonopah	197	....
New York Central (*b*)	....	240
New York & Ottawa (*b*)	....	36
Northern Pacific	....	394
Northwestern Pacific (*d*)	487	....
Oregon Short Line (*e*)	....	48
Oregon-Washington R.R. & Nav. Co	....	367
San Antonio & Aransas Pass	723	....
San Diego & South Eastern	67	7
San Pedro, Los Angeles & Salt Lake	656	207
Southern Pacific (Total 9,566 miles) :		
Lines East of El Paso (including Galveston, Harrisburg & San Antonio ; Houston East & West Texas ; Houston & Shreveport ; Houston & Texas Central ; Louisiana Western ; Texas & New Orleans ; Morgans La. & Texas R.R. & S.S. Co.)	1,967	994
Lines West of El Paso (S.P. Co.)	6,374	....
Pacific Railway & Navigation Co	91	....
Cornwallis & Eastern	140	....
Spokane, Portland & Seattle ; Oregon Trunk	707	....
Tonopah & Goldfield	110	....
Tonopah & Tidewater	254	....
Trinity & Brazos Valley	462	....
Washington, Idaho & Montana	48	....
Western Pacific (*f*)	665	135
Total for lines in U. S. (25,630 miles)	20,910	4,720

Name of Railway Line	Oil Used Exclusively (miles)	Oil in Partial Use (miles)
Lines in Canada.		
Canadian Pacific	338	....
Esquimalt & Nanaimo	134	....
Great Northern (*g*)	115	....
	587	....

Grand Totals for United States and Canada

Miles of Railway Line using Oil Fuel exclusively	21,497
" " " " both Oil and Coal	4,720
Grand total for United States and Canada (miles)	26,217

(*a*) Experimental basis only.
(*b*) Oil used exclusively during daytime, in fire season only; Order Public Service Commission of N. Y.
(*c*) See also lines in Canada.
(*d*) Including 110 miles under construction.
(*e*) Fire season only; line in National Forest.
(*f*) Coal-burning engines on 135 miles noted are in process of conversion to oil.
(*g*) See also Lines in U. S.

RAILWAYS

"The following table* of railway consumption of fuel oil is given because it is practicable to present sufficiently accurate statistics to show the marked gain in each year, and because this use is especially popular because of the added comforts from freedom from coal cinders, because of avoiding the danger of forest fires, and particularly because of the saving in labour. In fact, the weight of trains where coal is burned on mountain divisions is limited by the endurance of the fireman, until the coal can be replaced by oil. In recommending the adoption of fuel oil on the mountain divisions of the Canadian Pacific Railway, William Whyte, second vice-president, states that one of the reasons for this change is the removal of danger from conflagrations in the great forests of British Columbia. He also alludes to the failure of immense locomotives now in use, saying: 'It is not the failure of the locomotives; it is the failure of the fireman.' A fireman shovelling coal on one of these locomotives for a distance of 130 miles is physically exhausted before getting to the end of the run. The Southern Pacific uses over 1,200 oil-burning locomotives; the Santa Fe over 800; the Northern Pacific 20; and the Great Northern 115.

"Thus far in locomotive use oil has simply replaced coal under boilers, but within the last year a locomotive has been constructed in

*Extract from "The Production of Petroleum in 1911," by David T. Day, Department of the Interior—U. S. Geological Survey.

Switzerland on the Diesel principle and is being subjected to thorough practical tests."

CONSUMPTION OF FUEL OIL BY THE RAILWAYS OF THE UNITED STATES, 1906-1911.

YEAR	Length of line operated by the use of * fuel oil	Quantity of fuel oil consumed by railways	Total mileage made by oil-burning engines	Average number of miles per barrel of oil consumed
	Miles	Barrels	Miles	Miles
1906	.....	15,577,677	.....	.....
1907	13,573	18,849,803	74,079,726	3.93
1908	15,474	16,870,882	64,279,509	3.81
1909	17,676	19,905,335	72,918,118	3.66
1910	22,709	23,817,346	89,107,883	3.74
1911	27,368	27,774,821	104,270,964	3.75

The Oil-Burning Situation in the Adirondacks

In 1909, upon application of the New York Forest, Fish and Game Commission, the Public Service Commission of that State ordered the railways running through the Forest Preserve to show cause why they should not either use some fuel upon their locomotive engines which would not give out sparks and set fires, or why their motive power should not be changed to some other than steam.

In its application for an order, the Forest, Fish and Game Commission set forth that enormous damage had been caused by forest fires in the Adirondacks, that 90 per cent of the fires in the Forest Preserve were started by sparks from railway locomotives, and that the most diligent inspections of fire-protective appliances on coal-burning locomotives, by officers of the Commission, as well as the exercise of the utmost care by the railway companies, had failed to prevent the regularly recurrent fires. The prohibition of the use of coal as locomotive fuel during the fire season was urged in this connection. The railway companies affected were the Delaware & Hudson, and the New York Central system, including the New York and Ottawa.

The following extracts and abstracts are from the formal opinion of the Commission, dated April 1, 1909.

It was shown at the first hearing that the only railroad in the Adirondack region which had been free from fire complaints was the Raquette Lake, about 19 miles long, running from Clearwater junction to Raquette Lake, which had been in operation for about 10 years, and which burned oil in the summer and coal in the winter.

*Some of these lines also used coal.

The remedies suggested by the railway companies included improvements in fire-protective appliances on coal-burning locomotives, cleaning right of way, patrolling, telephone system, and use of fire trains. The Public Service Commission did not, however, consider these adequate under the unusual and peculiar conditions existing in the Adirondacks. The limiting provisions of the constitution and laws of the State were to a very large extent responsible for this situation. The cost of electrifying the portions of the railways in question, was considered prohibitive.

After investigation and discussion, the unit cost of oil per gallon was taken at 2.4 cents, the transportation cost of oil and coal as one-half cent per ton per mile, and four barrels or 168 gallons of fuel oil as equal to one ton of good bituminous coal. The cost of repairs for fire-boxes was considered at least as low, and probably lower, with oil than with coal.

It was shown that the cost of converting locomotives from coal to oil burners averages from $350 to $650 per engine, according to the size and capacity of oil tanks required. A general average cost is $530. To change back to coal burning, with all the coal burning equipment at hand that had been displaced from the engine, would cost approximately $25 per engine.

The proportion of fire damage chargeable to the railways does not exceed 40 per cent, and may be considerably less, leaving at least 60 per cent due to other causes. The undoubted additional cost of using oil fuel in the Adirondacks is materially decreased by decrease in damage claims and by provision for using coal-burners on night runs, since it was shown that in the region in question the danger of fires starting in the night is practically negligible.

"Each serious fire in the forest leaves 'fire slash,' which is far more inflammable than the original forest, and greatly increases the chance of fires catching. The second burning of such areas frequently destroys the vegetable material which forms the floor of the forest, makes reforestation impossible, and destroys the results of centuries of growth." The railroads have failed to use all the precautions in their power to prevent fires.

The following paragraphs are quoted in full from the Opinion :

"In determining the question finally, consideration should be given to the correspondence with the locomotive builders, Supplement No. 2, and to their answers to the following questions : 'Provided locomotives are designed especially for the Adirondacks, with a view to securing the utmost possible safety against setting fires, consistent with successful operation in heavy passenger and freight service, how would such locomotives compare in safety with oil burning locomotives ?'

"To this question Mr. Vauclain, General Superintendent of the Baldwin Locomotive Works, answers : 'We think that, while locomotives so designed, would compare favourably with oil-burning locomotives, they would, of course, not be as absolutely certain from the non-fire producing point of view as oil burning locomotives, where we have absolutely no sparking and no chance whatever for the setting of fire to property by the locomotives.'

"Mr. Cole, Chief Mechanical Engineer of the American Locomotive Company, answers : 'Such locomotives would not offer as complete protection, even under the best condition of maintenance and with a reasonable degree of operating efficiency, as oil burning locomotives. With the latter the question of danger from lack of maintenance and carelessness in installation is minimized, the degree of spark throwing not being dependent upon these two conditions.'

"In the correspondence with the officers of the Southern Pacific Company, Supplement No. 6, the answer of Mr. H. J. Small, General Superintendent of Motive Power, to the following question is of interest : 'Have you found it practicable to safeguard the operation of coal burning locomotives sufficiently by the use of improved spark-arrester apparatus, improved ash-pans, cleaning the right of way of combustible matter, or patrolling the lines, so that the fire risk from coal burning locomotives is reduced practically to that from oil burning locomotives ?'

"Answer : 'With the best possible safeguards applied to coal burning locomotives, it is impossible to prevent sparks being thrown from the stack ; to remove all combustible matter from the right of way and patrol the line thoroughly with proper appliances for fighting fire, the fire risk might be reduced somewhat, but even then it would be a question whether or not the patrolmen would be at the proper place at the proper time to stop the fire.' "

For the above reasons, the Commission concluded that it was clearly its duty to make such an order as should amount to a positive guarantee that no further damage should be caused by railroad fires in the Forest Preserve. An Order was accordingly issued, requiring the railroads operating within the Adirondack Forest Preserve to burn oil upon all locomotives operated in the daytime from April 15 to November 1 of each year, but permitting the use of coal-burning locomotives at night, provided such locomotives had been examined by the inspectors of the Commission, and certificates of inspection issued.

As showing the later working of the Order, the following is quoted from the Fourth Annual Report of the Public Service Commission, Second District, of the State of New York, for the year ended December

31, 1910 : "No serious difficulty has been found in the practical use of oil as a fuel. The question is simply one of cost, and this is decidedly less than the estimate upon which the Commission based its order. * * * * With the experience of the year 1910, the use of oil-burning locomotives in the Adirondacks may be said to have passed the experimental stage, and no satisfactory reason has yet been presented to the Commission against the continued use of oil for day service during the period of fire risk."

Symposium

There has been considerable discussion and difference of opinion with regard to the relative merits of oil and coal as locomotive fuel, and as to the extent to which the fire danger is eliminated by the use of oil for this purpose. In order to get as much information as possible in this connection, extracts or abstracts have been made from available articles bearing on the subject, and, in addition to this, many statements have been secured as a result of correspondence. The more important extracts are included in the following pages and the remainder may be found in the appendix.

The information obtained in this way comes from a variety of sources, including railway officials, representatives of oil companies, district and chief foresters and lumber companies owning and operating their own railway lines. In this manner diverse points of view have been obtained and much valuable information secured with regard to the attitude of the various parties concerned. To facilitate a comprehension of the various points of view the communications in question are presented in this volume in a geographical order ; that is to say, they have been arranged in a grouping which follows a sequence embracing the Atlantic States of the Union, the Southern States, the Pacific Slope and British Columbia.

Practically all of these communications bear witness to the fact that forest fires, due to oil burning locomotives, are of the very rarest occurrence ; and that the danger of conflagrations from this type of engine may be under certain circumstances, completely eliminated. It will, however, be seen, that, from an economic view point, the use of oil is a different matter ; and it is of interest to note, that, in so far as the Eastern railways are concerned, the price of oil is a very great drawback to its utilization in this way.

With regard to the danger from sparks, in connection with oil burning locomotives, it appears from this correspondence that this can

be almost completely nullified if the fireman attends to the sanding of the flues in a proper manner. There are also a number of points mentioned in connection with the mechanical end of the matter and with regard to the maintenance and repair of oil burning locomotives. It also appears that the use of fuel oil is advantageous where there is a danger of snow blockade.

Supervisor of Equipment, Public Service Commission, State of New York, Second District.—There is a scale which forms on the tubes and which is occasionally released and goes into the atmosphere in a luminous condition. This carbonaceous matter has not been noticed as coming out in large particles.

It is our opinion that there is no necessity for a screen in the front end where crude oil is used.

We have had no reason to doubt the complete efficiency of oil as a fire-preventative so far as the locomotive is concerned.

We do not know of any cases where there is reason to suppose fire has been caused by an oil burning locomotive.

We consider that the abolishment of special patrols is justified where oil is used exclusively, assuming that section men and other regular employees of the railway companies will be fully instructed as to the reporting and extinguishing of fires, in connection with their regular work.

After our experience of three or four years in the Adirondack Forest Preserve with oil burning locomotives, we are of the opinion that oil burning locomotives eliminate all fires for which locomotives were heretofore responsible.

Chairman, Conservation Commission, State of New York.—The oil used by the New York Central and the Delaware & Hudson railway is supplied by the Standard Oil Company, and is delivered to the railroad companies at Albany. It is shipped to Albany from Texas in oil barges ; price, 2 4-10 cents per gallon f.o.b. Albany.

I am advised that one of the essential factors in securing the use of oil, in the Adirondacks, was the price which was quoted, and the Standard Oil Company gave a price for a period of 5 years. I do not know why oil could not be shipped from Galveston to Montreal and other points as well as to Albany.

I am informed by the Public Service Commission that there are no large railroad companies in the country which use oil exclusively, only about 6,000 locomotives in the United States out of about 70,000 being at present equipped for the use of oil.

The use of oil is governed largely by local economic conditions, proximity of oil fields and remoteness of coal mines naturally being the main determining factor and the use of oil fluctuates as oil sections become exhausted or as new fields are opened up.

The Delaware and Hudson Company.—I would advise that the portion of our line on which we burn oil is a branch 83 miles long, extending from Plattsburg to Lake Placid, N.Y., passing through the State Forest Preserve.

During the oil burning season last year oil cost us a fraction over 4c. per gallon, with a cost of $0.432 per engine mile. This year we figure it will cost us not less than 5c. per gallon.

At the same time, coal cost us in 1912, $2.28 per ton, and using the same mileage as operated by oil burning engines it would have cost us $0.132 per engine mile. The excess cost of burning oil over coal for 1912 was $56,082.

As a fire preventive measure it is very satisfactory, but the expense is entirely too great. For a much less expense I believe an effective patrol system could be installed and, I think, one just as satisfactory.

C. S. Sims, Second Vice-president and General Manager, The Delaware & Hudson Railway Company. (Relative to lines in the Adirondacks, where use of oil is compulsory by Order of the Public Service Commission.)—During the oil burning season of 1909 coal was charged at $1.82 per ton. The cost per engine mile on this basis was 10.46c.

In 1910 oil cost $57,260.33 at 2.25c. per gallon or 28.33c. per engine mile, or $36,045.88 in excess of doing the work with coal.

In 1911 oil cost $49,916.81 at 2.25c. per gallon, or 25.21c. per engine mile, or $26,677.25 in excess of doing the work with coal.

The coming season of 1912 we are obliged to contract for our fuel oil requirements at an average price of 3.77c. per gallon ; the last million gallons, approximately, at a price of 4.25c. per gallon, or a total price of oil for 1912 of $83,703.31. Coal at the rate of $2.45, which is the rate at which coal was charged for the months of January and February of this year, would show an increased cost of using oil instead of coal of $56,454.96.

For three years, 1910-1912, the increased cost of using oil for fuel has been $119,077.09.

For a much lower price we could instal a wonderfully effective patrol system.

Extract from address by H. R. Bristol, Superintendent of Woodlands, Delaware & Hudson Railway Company ; read at Forest Conference, in the White Mountains, July 12, 1912, under the auspices of the Society for

the Protection of New Hampshire Forests.—Our engine mileage in 1910 was 202,000, approximately; in 1911, 197,000. The number of gallons of oil burned in 1910 was 2,460,455, that is, from the time we started in April until we quit in November. In 1911, it was 2,218,525. Of course, we are not through with this year as yet and the figures which I give for this year's operations are as close as may be. Our total cost of oil in 1909 was $57,260.33; in 1911, $49,916.81. The cost per engine mile in 1910 was $0.2823; in 1911, a trifle less—$0.2521. As to the cost of burning coal as compared with oil, I will not go into the detail of these figures, but the cost of burning coal per engine mile in 1910 was $0.1046 as against $0.2823 for oil; and in 1911, $0.1174, as against $0.2521, or an increase per engine mile due to the burning of oil in 1910 of $0.1777, and in 1911 an increase of $0.1347. Now, in 1912, assuming the same engine mileage as 1911, in other words, 197,952 miles, at the price we have to pay for oil, the cost of operating our oil burners figures out to $0.4227 as against $0.2521 for the last year. I do not know whether there are any oil men here or not, but this increase was due to the fact that the old Standard Oil Company is not in existence. Our oil cost us in 1910, 2⅓ cents a gallon while the last million gallons which we purchased in the early part of this year cost us 4¼ cents, or an increase of nearly 100 per cent. Our increased cost per engine mile for 1912 over the cost of burning coal is $0.2845, and this means, where we are operating our oil-burning locomotives, a total added operating cost on this division of 12½ per cent, so that when you are thinking of forcing railroads—perhaps you are not—to burn oil, it is worth while considering the matter pretty carefully, because there are a good many railroads, particularly some of these smaller roads, that really cannot stand it.

New York Central & Hudson River R. R. Co.—The influence of oil burning upon the question of fires has no doubt resulted beneficially, as a fraction of the fire losses in the forest regions were attributable to fires started by locomotives.

The cost of oil for fuel is 80 per cent higher than coal.

We have not dispensed with the other measures for fire protection.

District Forester, U. S. Forest Service, Missoula, Mont.—On the St. Joe Forest, some little trouble has been experienced with fires along the right of way of the C. M. & P. S. railroad, but it is hard to state whether these fires were caused by tramps or by the locomotives. In only one instance is Supervisor Spaulding reasonably sure that an oil burning locomotive started a rather serious fire. This was on the Lolo National Forest near Lothrop, Montana, in 1910. Eye witnesses stated that the fire was directly caused by a freight engine on the railroad. A sheet of flame composed of burning carbon and molten sand was ejected from the smoke stack to the right of way. Mr. Spaulding advises me that,

subsequent to this fire, he made a rather careful study of the possibilities of oil burning locomotives setting fire to the right of way, and found, that, under certain circumstances, the oil burning engine could be as dangerous, if not more dangerous, than the ordinary coal burner. The crude oil in use as fuel throughout western Montana and northern Idaho has a heavy percentage of carbon. This carbon clings to the flues and stack of the engine despite the ordinary heavy draft. A coating of this oil-soaked carbon in the flues decreases the steaming power. In order to get rid of the carbon, the engines are equipped with an extra supply of sand. This sand is shot forcibly through the flues and out of the stack. A green fireman sometimes allows the soot to accumulate in the flues until it becomes difficult for him to maintain the requisite steam pressure. The accumulated carbon in the flues may commence burning. The fireman shoots in his sand and forces the burning oil-soaked soot out of the smoke stack in a sheet of flame. This settles on the right of way and would naturally set fire to any inflammable material with which it came in contact. With an experienced fireman this danger is reduced to the minimum, since it is to his advantage to keep his flues from becoming clogged with soot, by frequent injections of sand.

President of Lake Whatcom Logging Co., Bellingham, Wash.—We consider our locomotives as absolutely safe from fire, but just as much, or even perhaps, greater, skill is required in firing with oil, than in firing with coal or wood; with proper application of dry sand at the right time the flues are kept swept clean of any accumulations such as you describe.

J. L. Bridge, Chief Fire Warden, Washington Forest Fire Association, Seattle, Wash.—There is certainly less fire risk in connection with the use of oil as fuel than in either coal or wood and in Western Washington we have been urging the use of oil with railway companies, logging companies, and others who use locomotives in the course of their operations. Since the installation of oil burning locomotives on some of the railway lines in Western Washington, we have considered it safe to greatly reduce our patrol in these localities. Railways, of course, are highways for tramps, and for this reason we have felt that they needed a certain amount of watching, but the risk of fire being started by the locomotives is cut to a minimum.

Northwestern Pacific Railroad Co.—In comparing the cost of coal and oil, our experience shows that four barrels of oil are approximately equal to a ton (2240 lbs.) of coal. The ruling price of oil in this market now is 75c. a barrel. I do not believe you could buy Australian or British Columbia steam coal by the cargo, for less than $6.50 a ton. These prices vary, of course, for both coal and oil, but the difference in cost as fuel is always largely in favour of oil. It has other advantages

in the ease of handling and control in firing. It is a very valuable insurance, furthermore, as against fire, the danger from its use in this respect being practically nil.

Washintgon, Idaho & Montana Railway Company.—We have found the use of oil as fuel on our engines, very satisfactory. The engine men like the oil much better than coal and there is less work for the fireman to do. It is much easier to keep up steam with oil than with coal, and better time can be made on the road for this reason. The cost of coal delivered at Potlatch, averaged $6.00 per ton, with an additional cost of unloading in the neighbourhood of 12c. a ton. The price of fuel oil delivered here is 0.0415 per gallon and our records show that 125 to 130 gallons of oil is as good to us as one ton of coal, making a gain of about 70c. on a ton of coal, or 12⅔ per cent.

To offset the economy of oil over coal, the up-keep cost on fire-box, flues and rivets, is higher, as the heat is more severe ; there is also the expense of renewing the fire-box lining and arch lining with new fire brick every three to six months.

We believe, however, that, on the basis of prices that fuels cost us, the use of oil is a little more economical than the use of coal, all things considered. So far as the danger of setting fires is concerned, oil is much safer than coal, and our experience through two dry seasons, has amply proven this to us.

Idaho & Washington Northern Railroad.—Would say we now have 12 out of 13 locomotives equipped for oil burning, and this was done primarily as a prevention of forest fires. From a cost of operating standpoint it about breaks even. Considering this phase, the price of oil compared with coal would necessarily be based on location, that is, in one place coal would be cheaper than oil, or vice versa.

So far as I know, we are the first inland road on the Coast to adopt oil as fuel. We previously used British Columbia Bellevue mines coal, which was the best we could secure, considering steaming qualities, for which we paid $5.15 per ton, f.o.b. Spirit Lake. The oil now used comes from the California oil fields by boat to Tacoma, and thence by rail, costing $1.91 per bbl. at Spirit Lake. The relative consumption is about 3½ bbls. of oil to one ton of coal. In figuring the cost the division of the rates which accrue to this Company must be taken into consideration and in our case coal would be a trifle cheaper, but considering the efficiency obtained from locomotives, on account of superior steaming qualities, less labour being required to hostle engines, etc., the cost is approximately the same for oil.

There is, however, another matter which must be given serious consideration and that is, on account of the superior steaming qualities

of oil, great care must be exercised by enginemen or damage to fire boxes of locomotives would be considerable. When an engine is working hard with the burner fully opened, and the engine is suddenly shut off and the burner closed up to minimum, if the cold air dampers are not closed, cold air takes the place of heated air and the contraction of the sheets would be rather excessive, and, as a consequence, would cause flues to leak or sheets to crack. However, on small lines like ours, we are able to hold this danger down to a minimum by personal supervision and strict discipline, and by having dampers located in a convenient position so that they can be closed as the flow of oil is reduced. By watching this closely the damage to fire boxes has been very little if any more than with coal.

During the last two weeks we have had unusual snow conditions, and the use of oil, as compared with coal, has proven a large factor in keeping the road open. The old type of locomotives, equipped with narrow, low fire boxes, are objectionable from an oil burning standpoint for the reason that boiler inspection laws of this country require tests of stay bolts every thirty days, and with this type of engine it would be necessary to remove a great many of the fire brick for such an inspection ; also in deep snow the fire box is liable to be filled up through dampers and choke out the burner, and an oil burner cannot be steamed without a proper amount of air.

Were we able to get as good a coal as the Pocohontas of West Virginia, or the better grades of bituminous from Pennsylvania, the efficiency of locomotives between oil and coal would not be so great, and, from a cost standpoint, coal would be preferable. With the poorer grades of coal however, the difference in favour of oil is considerable.

As a fire preventative oil is far superior, but, while it is said there are no sparks from this class of fuel, there is a soot that forms in flues, particularly if the burner gets a little dirty, and in cleaning this soot from flues, which is done on the road by opening engine with a heavy exhaust, this soot takes fire causing sparks. These sparks, however, are thrown high in the air and do not remain lighted far from the stack, and there is not much danger of fire on this account ; but in many places through California or Oregon they do or have had, grass fires from oil burners. Also, great care must be used not to put pieces of wood, waste or such material in fire boxes as there is no netting or stoppage of any kind to arrest discharge of such.

I will add that we run through a heavily timbered region, and from a fire setting point of view I think the danger has been reduced at least 99 per cent. I am of the opinion that many of the fires alleged to be set by locomotives are really caused by trespassers or the throwing

of lighted cigars and cigarette stubs from passenger trains during extremely dry weather.

Associated Oil Company, San Francisco, Cal.—Answering your inquiry in regard to fire danger when oil is used as locomotive fuel, I am pleased to state that this Company has no knowledge of any forest or grain fire caused by locomotives consuming fuel oil, and as a matter of fact, it is considered that the use of oil for such purpose has practically eliminated the danger of such fires. At the present time, practically all of the railways in California, with the exception of logging roads in some of the inaccessible districts, are using oil as fuel. In fact, the logging companies, whenever located at points where the delivery of oil is possible, are employing same as fuel for their locomotives as a measure for the prevention of forest fires.

Regarding the question of prices : At the present writing the cost of fuel oil is ninety cents (90c.) per barrel of 42 U.S. gallons (231 cu. in.) f.o.b. cars Seattle. It is likely that we will be able to arrange to load cars at Vancouver at approximately the same figure, although at the present time it is impossible to promise an arrangement of this kind, and before giving you a fixed quotation at either point, it would be necessary to go more fully into the question of necessary tank car equipment.

The price of oil has slowly risen for about a year past,—a result of the unusual demand for oil following the period of depression in prices due to a temporary overproduction. In all probability the price will advance still further owing to heavy demands likely to be made upon California fuel oil in anticipation of the early opening of the Panama canal.

Manager of Fuel Oil Department, The Texas Company, Houston, Texas.—I have never heard of a single instance where fire, such as would be communicated from a coal burning locomotive, was communicated to a right-of-way or any property from an oil burning locomotive. As a matter of fact, roads having oil burning locomotives in this territory handle cotton in open cars, and it is no uncommon sight to see such railroads as the Southern Pacific system, International & Great Northern, and Gulf Colorado & Santa Fe handle from ten to twenty cars of exposed cotton in their trains behind an oil burning locomotive, and I have seen probably two or three hundred cars of exposed cotton in the yards of these companies at Houston and Galveston, in which yards the switch engines are equipped for burning oil.

The rule in this territory is in handling exposed cotton, where they meet an opposing train, if the opposing train is being hauled by a coal

burning engine, regardless of whether it has the right of track or not the train in question must take the siding so as to avoid any possible chance of sparks or cinders from the coal burning engine being communicated to the exposed cotton in the train being hauled by the oil burning engine.

Northern Pacific Railway Company.—It is my understanding that we have yet had no case of fire set out by oil burning engines.

Rock Island Lines.—Due to the increased cost of fuel oil, we are now converting all oil burning locomotives back to coal burners; expect to have all our locomotives of the coal burning type by April 30th, 1913.

The Atchison, Topeka and Santa Fe Railway System.—As to the territory in which both oil and coal are used we discontinued the use of oil in Kansas and Oklahoma north of Purcell and Shawnee, change being necessary on account of our inability to secure a sufficient supply of fuel oil. We have found the use of oil entirely satisfactory from a fire preventive point of view.

General Superintendent of Motive Power, Southern Pacific Co., San Francisco, Cal.—Our experience has shown that the use of oil fuel in locomotives greatly eliminates the danger, though not absolutely. If masses of oil soot are allowed to accumulate in front end or passages to stack, as is likely to occur when an engine is standing for some time, we have known cases where pieces of carbon have been thrown out of the stack in a burning condition. It does not often happen, however, that this carbon ever strikes the right-of-way in such condition. In the process of sanding, the accumulation of soot is driven out of the stack and shows to be red hot at the point adjacent to the top of the stack. Red hot sand cools very quickly, however, and does not reach the right-of-way in a red hot condition. As a general thing, the fires caused by coal burning locomotives result from masses of burning solid coke cinders, from coal burners.

Our records show that in former times with coal burning engines, our losses in damage claims from fires set by locomotives amounted to an average of $100,000.00 per year, and sometimes in excess of that figure. Since burning oil these damages have averaged from $4,000.00 to $7,000.00 a year. We have roughly, therefore, one-sixteenth the amount of damage done by oil burners as compared with coal burners.

In connection with this matter it should be stated that proper care should be exercised in oil burning matters, so that foreign substances such as sticks, waste, etc., may not be introduced into the fire-box. Also that there should be a regular inspection made of

locomotives at terminals, with respect to front end carbon deposits. If, through peculiar conditions, such an accumulation is formed, it should be removed before engines go into road service.

Southern Pacific System (Lines East of El Paso).—Because of the fact that oil for fuel creates fewer sparks the fire risk is materially decreased in proportion. Compared with coal it is usually estimated that four barrels will equal a ton of coal when used as fuel.

The relative cost of operation varies entirely with the proximity of a railroad to either oil or coal fields, or both ; therefore, figures covering cost in one locality would not apply to the cost in another locality. At present oil is gradually increasing in value due to the depletion of the sources of supply.

Southern Pacific Company (Lines West of El Paso).—In the fiscal year ending June 30th, 1911, the Salt Lake Division was operated as a part of the Oregon Short Line, and the Southern Pacific Company (Pacific system) used oil exclusively. During the same period the Union Pacific was operated exclusively by coal. A comparison of fuel costs on the main line of these two systems will give a fair idea of the relative cost of operating with oil and with coal. Four barrels of oil are considered equivalent to one ton of coal. The cost in freight service on main line of Union Pacific was $1.91 per 100 gross ton miles and on the Southern Pacific $2.11, but the fuel cost per ton of coal on the Union Pacific was only $1.76, while on the Southern Pacific it was $2.32. If fuel on each line had cost $2.32 per ton, the cost per 100 gross ton miles on the Union Pacific would have been $2.52 and on the Southern Pacific $2.11. The Southern Pacific has heavier average grades than the Union Pacific, or the oil burning engines would have made a better comparative showing.

Engines cause occasional fires along our right-of-way, but these are due to improper or infrequent sanding of flues.

Southern Pacific Railway (Lines West of El Paso).—With regard to fires caused by oil burning engines ; it is difficult to segregate these from other fires along our right-of-way. If instructions outlined in enclosed pamphlet* are followed, there is little danger from fire. The fireman can usually choose places along the line to sand the flues where there is nothing that will take fire readily if any burning soot should fall.

A coke-like deposit forms slowly in fire-box and ash-pan, and requires chipping to remove. This carbonaceous substance does not

* See Appendix, p. 160

form rapidly, especially if the burners are properly designed and maintained.

John D. Isaccs, Consulting Engineer, Union Pacific Railroad Company, Oregon Short Line Railroad Company, Oregon-Washington Railroad and Navigation Company, Southern Pacific Company.—The advantages of oil-burners versus coal-burners are almost entirely in favour of oil and the following are some of these advantages.

1. Higher heat value of the oil for the same weight of fuel.
2. Higher efficiency of the boiler with the use of oil.
3. No ashes to handle.
4. Firing is simplified and more uniform.
5. Oil can be stored without deterioration and is easier to handle from storage to locomotives.
6. No sparks or cinders to cause fire or annoy passengers.
7. Less smoke from oil when properly fired.
8. No waste due to banking of fires.

In general if 3½ barrels of oil can be obtained at the point of use for the same or a lower price, than one ton of average bituminous coal, oil firing of a locomotive is the most satisfactory fuel.

San Pedro, Los Angeles and Salt Lake Railroad Company.—The use of crude oil as locomotive fuel is quite satisfactory, and, while we did not adopt it as a fire preventive measure, there is little doubt but that fewer fires are started by oil burning locomotives than by those which burn coal, owing to the absence of cinders.

The present price of oil f.o.b. Los Angeles is 63c. per barrel of 42 gallons. We have determined by experimental tests that four barrels of oil will equal one ton of coal in producing steam.

The dividing point on our line, as between oil burning and coal burning locomotives, is determined largely by the price of both oil and coal, and at the present time the cost is practically equalized at Milford, Utah, which is one of our district terminals.

Great Northern Railway Company.—The use of oil is satisfactory from a fire preventive standpoint.

We figure that four barrels of oil (168 gallons) are equal to one ton of coal.

The oil, as compared with coal, figuring freight rates, costs about one-third less at present prices.

Acting District Forester, U. S. Forest Service, Portland, Oregon.—I sent a representative of this office to call on officials of the Southern Pacific and make enquiries concerning certain phases of the use of fuel

oil in locomotives. The officials stated that they had been using fuel oil for a period of seven years on the northern division of their system. Their power equipment consists of over 200 locomotives, although they had not that number when oil burning was first adopted. During the seven years they have had only one fire along a right of way which was charged to an oil burning locomotive. The boiler inspector gave the matter careful investigation on the ground, and reached the conclusion that it was not the oil, but twigs from unscreened sand which caused the fire. The master mechanic stated that twigs, etc., in unscreened sand, waste paper, or other material thrown into the fire-box may in certain instances be carried out through the stack in a blazing condition.

So far as fires being started from the carbonaceous material, which accumulated on the baffle wall in the rear of the fire-box, are concerned, both the chief inspector and the master mechanic said they considered it practically impossible for a fire to originate from this source. They called special attention, however, to the fact that there is a heavy deposit on the rear baffle wall and that there is no deposit on the sides of the fire-box. They stated that the deposit on the rear baffle wall forms in the shape of a cone and is so hard and firmly attached to the brick that it is necessary to loosen it with a pick. An inexperienced workman is likely to destroy the brick in the baffle wall in trying to remove the carbonaceous deposit. In fact, skilled workmen frequently break out portions of the brick. Under separate cover I am sending you two small samples which show pieces of brick adhering.

Both men stated that the quality or quantity of oil used would make no change in the danger from the carbonaceous deposit. They said that an inexperienced fireman might flood the fire-box with oil to such an extent that some of it might drop to the track but this could occur only when starting out from stations or from places where stops are made.

Summing the whole matter up, the men interviewed stated that the danger from oil burning locomotives is reduced to the lowest minimum that it is possible for human ingenuity to devise. It is believed that patrolling for fires starting from oil burning locomotives is almost useless. It is possible that some of the fires attributed to oil burning locomotives have resulted from burning tobacco or matches thrown away by passengers.

E. T. Allen, in "Practical Forestry in the Pacific Northwest."—The most fruitful source of fire is spark emitting locomotives and logging engines. Much data has been collected showing that with oil at a reasonable price its use is economical from a labour saving point of

view, as well as from that of safety. It reduces expense for watchmen, patrol, fuel cutting, fire-box cleaning and fire. And since it is an absolute preventative while all other measures merely seek to miminize the risk, it is probable that, even where the cost of the oil more than balances these savings, it will save in the long run by averting a costly fire.

C. S. Chapman, Secretary and Manager, Oregon Forest Fire Association.—My opinion would be that special patrols could be abolished were oil used exclusively. However, we have had some cases where railroads stated they would burn oil, and then, when pushed, ran out a few coal burners and set fires.

Oil is being quite extensively used in logging locomotives down here with excellent results. How much chance there is of fire when oil is poorly handled, I know little of, but I do know that our experience with oil has been entirely satisfactory.

H. R. MacMillan, Chief Forester, B.C. Forest Branch.—The records of this office, while they show that a large number of fires are reported as having been caused by the escape of sparks from locomotives, or by the dumping of ash pans, cannot be used as entirely valid evidence since, in most cases, the start of the fires was not observed and the cause was merely conjectured. The only good evidence that I know of in regard to the starting of fires, through the escape of sparks and the dumping of ash pans, is the known fact that where railways run through wheat or hay fields fires are frequently started, and I have myself seen, from the end of a train, a number of fires started from this cause. Further, on the Skagit branch of the Great Northern in the State of Washington, which is very carefully patrolled by a ranger, 157 fires were reported in 1910 and it is certain that not more than half a dozen of these fires could have been due to any other cause.

I would like to say, in connection with the use of coal, that it seems to me utterly improbable that with the present investigations by many of the railway companies, by mechanical engineering departments and many universities, and by locomotive works in regard to safety devices for preventing the escape of fire from locomotives, that some really effective device will not be discovered before long, and, personally I believe that, considering the importance of the coal industry, we could well afford to allow several years for the development of such a device before definitely advocating the abandonment of coal and the adoption of oil for use in locomotives.

R. E. Benedict, Chief of Operation, B. C. Forest Branch.—There has never been any question that the use of oil as fuel on railway locomotives entirely eliminates the danger of fire escaping. Instances

have been mentioned to me of fires being set by so-called "flare backs" and also by the throwing out of the kind of cinders which you mention in your letter. Fires set from such causes, however, are extremely rare, so much so that they are practically negligible. About all it amounts to is that oil burning locomotives cannot be considered absolutely safe. In other words, I believe, oil burning locomotives are just about as safe as a locomotive can be made. I cannot give any specific instances of fires being set from the operation of oil burning locomotives, and can only say that, in talking with supervisors and rangers of forests through which logging trains or common carriers using oil burning locomotives operate, they have told me that fires have been set which undoubtedly were caused by the escape of cinders or flame from the locomotive.

As regards the abolishment of special patrols on railways using oil, I believe, as I said in my letter of January 2nd, that a railway is always a source of fire danger and should be provided with some kind of patrol. During ordinary weather the section crews, bridge watchmen and engineers on trains would undoubtedly be sufficient to handle the situation, but during July and August and sometimes for a week or two in the spring special patrol is, in my opinion, necessary.

Richelieu & Ontario Lines.—We are using oil as fuel on the two steamers running in the rapids service between Montreal and Prescott. These two steamers, "Rapids Prince" and "Rapids Queen" develop 1,000 i.h.p. each.

The oil fuel has been a complete success from a steaming standpoint, but the cost of oil last season, considering the two as fuel only (coal *versus* oil), was about 20 per cent more than coal.

This was more than compensated for by the steamers increased speed and freedom from firemen troubles, (that is keeping firemen while burning coal), a steamer which carried six firemen burning coal, carried two firemen burning oil.

We expect the price of oil will be considerably higher this season. Coal is also advancing in price.

General Manager, Cleveland-Sarnia Saw Mills Company, Sarnia, Ontario.—We have used fuel oil for our locomotives, which we operate on our railway above North Bay, for several years, but only use the oil during the summer months when the fire hazard is the greatest, starting in about the middle of May and continuing until about the 1st of October, depending upon the weather conditions.

We use the oil entirely as a fire protection, and of course find it very effective.

The cost of oil is much greater than coal, especially the last year when we had to pay 7.56c. per gal. delivered at Diver. We figure that 250 gals. of oil will equal about 1 ton of coal, and the average cost of coal is about $5.15 per ton delivered Diver, Ont. However, in using oil we save a fireman.

As to economy of burning fuel oil, the only advantage is the eliminating of the fire hazard. As you well know one fire is more expensive than $5.00 or $10.00 a day for two or three months. We find that we get as good results in steaming quality from the fuel oil as we do from coal.

Canadian Pacific Railway Co., Western Lines.—We contemplate extending the use of oil on locomotives to the West Coast during the present year.

The oil is at present purchased from the Union Oil Company of California by contract, its cost being seventy-three cents per barrel of forty-two United States gallons delivered without further charge on to tank cars at Vancouver.

We figure that 3.86 barrels of oil are about equal in steaming efficiency to one ton of the coal previously used in the territory where we now burn oil. The present cost of the coal would average $2.80 per ton.

Conclusions

(1) Sparks from coal-burning locomotives have in the past been a prolific source of fires.

(2) No fire-protective appliances have yet been devised which will wholly prevent the escape of live sparks from the stack.

(3) It requires close and continued inspection of fire-protective appliances, in order to maintain coal-burning locomotives in a condition of minimum fire danger. The inspection furnished in the past has not, in the case of most railway companies, been thoroughly efficient.

(4) The use of oil as fuel eliminates very nearly all the danger of fire due to locomotive operation.

(5) If the oil-burning apparatus is properly installed and maintained, and there is careful and intelligent operation by experienced men, the question of fire danger practically ceases to be an element in the problem. Little if any greater degree of care and experience is necessary with oil burners than with coal burners. The men must, however, be properly drilled to start with.

(6) The improper installation, maintenance or use of oil-burning appliances may, however, result in serious fire danger.

(7) Even with the best use of oil-burning appliances, there will still be danger of fire along railway lines, due (*a*) to carelessness by passengers or others in throwing burning cigars or cigarettes on the right-of-way ; (*b*) to careless or malicious action by tramps, or other pedestrians, in leaving camp or other fires burning along the right of way ; (*c*) to carelessness of section men in the use of fire, in clearing the right-of-way ; (*d*) other miscellaneous acts of carelessness by railway employees or the general public ; (*e*) natural causes (infrequent).

(8) In general, the establishment of a special system of fire patrols may be dispensed with along railway lines where oil is used exclusively as locomotive fuel. Watchfulness must still, however, be exercised by train and section crews in reporting and extinguishing any fires found burning along the right-of-way. In extreme cases, special patrol may still be necessary.

(9) The removal of inflammable material from the right-of-way is essential, even in oil-burning sections, on account of the possibility of fires from causes other than locomotive operation. The usual relaxation of patrol measures renders this especially important in oil-burning territory.

(10) A reasonably efficient system of railway fire-protection can be established in coal-burning territory by : (*a*) the maintenance in proper condition of the best fire-protective appliances on locomotives; (*b*) the maintenance of an efficient system of special patrols, supplemented by the issuance to all regular employees engaged in train and track work of special instructions with regard to the reporting and extinguishing of fires. In sections where the fire danger is inconsiderable, special patrol may not be necessary, provided suitable instructions to regular employees are issued and enforced ; (*c*) the proper clearing from the right of way, by burning at a safe time, of all unnecessary combustible matter.

(11) The great increase in oil-burning mileage on railways is due primarily to the fact that a saving can thus be made in operating expenses. Fire-prevention has in general been a secondary consideration, except in case of a requirement for the use of oil being made by some governmental authority.

(12) The constantly increasing price of fuel oil is seriously retarding the movement toward its more general use by railways.

(13) All the measures the railway companies can be expected or reasonably required to take toward fire protection, can never be wholly efficient, as long as lands adjacent to the right of way are allowed

to remain covered with slash and other inflammable débris. The present condition in this respect is thoroughly unsatisfactory, both in Canada and the United States, and legislation is urgently needed.

(14) The advantages of oil over coal as locomotive fuel may be briefly summarized as follows :

(*a*) Cheaper cost (within limited territory) ;

(*b*) Fire hazard greatly reduced ;

(*c*) Greater efficiency for hauling where trains are heavy, or where grades or snow conditions are extreme ;

(*d*) Easier and therefore cheaper to handle than coal ;

(*e*) Greater comfort of passengers ; elimination of cinders and smoke ;

(*f*) More reliable steam producer, insuring steadier maximum pressure ;

(*g*) Less deterioration in storage than coal ; less waste in general ;

(*h*) Less effort in firing, and consequent ability to retain better men ;

(*i*) Less cost for hostlers, engine crews, and other labour ; time saved in fueling ; no ashes to handle ;

(*j*) Engines not out of service for flue cleaning ;

(*k*) Increased mileage with same or less fuel weight and space ;

(*l*) Saving of time means fewer engines needed ;

(*m*) Great economy for intermittent service, since fires can be readily put out and started ; no waste due to banking of fires.

Part V

Forest Planting in Canada

THERE is an enormous area of non-agricultural land in Canada, which is suitable only for the production of timber. For this purpose, however, it is very valuable, and the best interests of the country demand that its productive capacity be fully utilized. The loss of timber resources by fire has been very great. An investigation by the Forestry Branch, Department of the Interior, indicates, that, of the original forest of Canada, half has been destroyed by fire, that for every foot of timber utilized, seven have been burned, and that at the low estimated value of 50 cents per thousand feet B.M., the timber uselessly destroyed by fire would have yielded a direct revenue of more than one billion dollars, in addition to the vast indirect benefits that would have resulted from its utilization. Contrary to the usual supposition, the forest resources of Canada are much less in amount than those of the United States,—probably not much, if any, more than one-fifth.

The question of the conservation of our forest resources thus becomes of the most pressing urgency to those who have a true interest in the permanent welfare of the country. The situation can in part be met by the better care and use of existing resources, and in part by the establishment of new resources through afforestation or reforestation.

The first method involves the question of fire protection, use of wood preservatives, elimination of waste in logging and manufacturing, and the use of substitutes, including the utilization of so-called inferior species as well as of substances other than wood. Along these lines, much progress is being made, but very much still remains to be accomplished.

The second method—the establishment of new forest resources —is a line of work along which, in Canada, the greatest progress has been made in the prairie sections of Alberta, Saskatchewan and Manitoba. The economic conditions in these sections are such as to demand the vigorous prosecution of tree-planting work. Here, where planting is necessary to the establishment of a forest, we have the best demonstration of the fact that the forest is a crop, differing from other crops only in the time element.

SCOTCH PINE AND JACK PINE PLANTATION ON BLOW-SAND FORMATION, NORFOLK FOREST STATION, ONTARIO
Large areas of such lands have been abandoned for agricultural purposes ; only suitable for the growing of timber.

The necessity for forest planting has not been strongly felt in Canada, except, as noted, in the Prairie Provinces, and to some extent in the older farming sections in Eastern Canada. This is principally due to the favourable climatic conditions, which cause cut-over or burned-over areas to reproduce themselves naturally, except where burns occur of great extent and severity, or where successive fires finally result in the destruction of all, or a very large percentage of the seed-trees of valuable species. Under these circumstances, brush or relatively worthless tree species cover the ground, and the re-establishment of a cover of valuable species may require generations, or be rendered wholly impossible without artificial means.

Where fire is kept out, the natural reproduction of the forest may, as a rule, be readily assured by the adoption of methods of logging having this end in view. Under a proper system of forestry practice, the character of the forest will improve, and an increased yield per acre will be secured from the next crop. The wonderful possibilities in this respect have been fully demonstrated by the forestry systems which have been in effect in parts of Europe for centuries.

Much progress has been made in Canada in decreasing the fire damage, and much better attention is also being given the question of ensuring the perpetuation of the forest by requiring the modification of old-style methods of lumbering on lands owned by the Dominion and Provincial Governments. Thus, in Canada, the planting problem, at least for the present, applies, principally to farms which have been denuded of timber or never had any, and to non-agricultural lands formerly forested but upon which the forest cover has been wholly, or in large part, destroyed by repeated fires.

The following statements summarize the principal planting activities with which the Dominion and Provincial Governments have been directly connected. No pretence is, however, made of entire completeness, nor is there here taken into account the very considerable amount of planting done by individuals, through the use of plant material secured from nurseries in the United States.

Forest Planting in British Columbia

By H. R. Christie, B.C. Forest Branch

It is estimated that British Columbia contains over 100,000,000 acres of woodland, of which upwards of 65,000,000 acres may be regarded as actually or potentially capable of producing merchantable timber, though outside of this the land is of relatively little value.

On this area Nature has been busy for a great many years storing up what is to-day one of the greatest of the few extensive reserves of commercial timber left in the world. It is estimated that this area contains over 300 billion feet board measure of timber, comprising over half the standing commercial timber of Canada. When the question of forest planting is linked with such a resource, it becomes of interest, even though the importance of planting to the perpetuity of the resource yet remains to be seen. So far, there has been no actual artificial reforestation in British Columbia either by sowing or planting. The subject must therefore be discussed from the standpoint of its potential, rather than from that of its actual development. The only actual tree planting in British Columbia has been in the line of horticulture, landscape gardening or shelter belts. While such planting is altogether different from forest planting, both in method and objects, some useful information bearing on the subject may nevertheless be deduced from its results.

The chief limitations to artificial reforestation are those imposed by Nature, those imposed by finance, and those imposed by policy. It is convenient to discuss the subject according to the above standpoints, under the following heads :

1. Silvicultural Considerations
2. Financial Considerations
3. Economic Considerations

1. *Silvicultural Considerations.*—All that a tree demands is suitable climate and soil. Give it plenty of light, warmth, air and moisture, with enough soil to anchor its roots and supply it with the small amount of mineral substance it needs, and it will grow and flourish.

British Columbia has enormous quantities of the above-mentioned necessities of life. Owing to a very favourable combination of soil and climate, nowhere, at least in the temperate zone, do trees grow more rapidly and persistently than on the Pacific slope of North America ; nowhere is natural reproduction more prolific and vigorous, as may be seen on hundreds of logged-over areas and old burns. In fact, this very readiness of nature to undertake the work renders discussion almost superfluous.

Experts, who have studied the question in the United States' state that perfectly satisfactory natural reproduction can be assured without much additional expense or modification of the existing logging methods. For any species, the prime requisites are proper utilization, with provision for a new crop by leaving seed trees or existing small trees ; and protection by slash-burning and protective organization.

For Douglas fir, clean-cutting and slash-burning to expose the mineral soil, which is the most favourable seed bed, is desirable.

As to proper utilization, while it is true there is now great waste, this is largely a question of market and will automatically adjust itself before long, just as it has done in the older parts of the country. In addition the Forest Branch is making every provision possible under existing conditions to obtain closer utilization. But, in a province which is cutting as yet only one-fifth of the annual growth of its forests it is not to be expected that as much finesse can be practised in methods of harvesting the crop, as in those countries which cut or use more than the annual growth.

As to slash disposal it is no exaggeration to say that British Columbia is just now in advance of the other provinces of Canada. Where others have been investigating and discussing, here they have simply gone ahead and burned the slash. So far, brush piling is compulsory only in connection with railway construction, but active steps are being taken to obtain the co-operation of all the loggers with the view of making the practice eventually universal.

It may be ventured then, that, in most of the forest areas of British Columbia which have been so far the objects of observation, artificial regeneration will never be more than supplementary and accessory to natural reproduction. Only in the southern interior of the Province, which is climatically and physically the northern extension of the inter-mountain dry belt of the United States, is artificial regeneration ever likely to play the leading role.

The feasibility of reproducing forests by planting or sowing has been so effectually demonstrated in other parts of the world, that it is unnecessary to dilate on it. There is no doubt that such plantations will thrive in British Columbia, at least wherever the natural forest has grown, and as far as native species are concerned. But is it possible to introduce exotic species ? Market conditions permitting, would it be possible to grow hardwoods in British Columbia ?

Possibility of Growing Exotic Hardwoods in British Columbia.— British Columbia must import the bulk of her hardwoods. A lack of something desirable is not always a cause for congratulation, but it is in this case because here there is something better ; nature has supplied British Columbia with conifers or softwoods instead of hardwoods. A glance at lumber statistics tells the story of their respective importance in the market. In Canada, in 1911, about 94 per cent, and in the United States, about 78 per cent of the total lumber cuts were supplied by conifers, the balance being supplied by hardwoods. The

hardwoods supply a smaller, but nevertheless, a very important part of the market, and it is desirable that some day British Columbia should supply her own requirements in this regard much more fully than at present.

Various theories, the discussion of which is not pertinent to the subject, have been advanced to explain why the forests of the Pacific slope are prevailingly coniferous or evergreen instead of hardwood or deciduous. One of these theories, however, touches on a vital point. It suggests that the explanation lies in the difference, in the east and west, of the distribution of rainfall between the summer, or growing season, and the winter, or period of rest. In the east, the distribution is quite even, so that, with a lesser total annual precipitation, more of it falls in the summer, favouring a deciduous growth. In the west, with a greater total annual precipitation, nearly all the precipitation falls during the winter or period of rest, thus favouring an evergreen growth.

The question arises then, is it possible for British Columbia to grow her own hardwoods ? Among the reasons for an affirmative answer may be mentioned :

(1) We have some native hardwoods as oak, maple, poplar, arbutus, etc.

(2) The growing season is longer and, at least in the lower altitudes, the climate is milder and more uniform.

(3) Exotic hardwoods planted as ornamental trees thrive exceedingly well.

(4) In forest planting of hardwoods, they would be guarded from dangerous competition of the evergreens.

No conclusive data exist in regard to actual forest planting of hardwoods in British Columbia, any more than with regard to softwoods. Nevertheless planting of a kind has been done at certain places. These include the Dominion experimental farms at Agassiz and Sidney, and Stadacona Park in Victoria.

Of the above, the Agassiz inspection proved by far the most interesting and important. The planting there has been done on two separate sites. The material for both was obtained chiefly from the Central Experimental Farm at Ottawa, and also from nurseries in the eastern United States, in the form of nuts and young trees two years old. No detailed records of origin were kept however.

The first and larger of these plantations is in the form of a shelter belt, planted 23 years ago with two-year-old stock on level ground, ex-

tending nearly the whole width of the farm from the highway back toward the steep hill against which the farm halts. There are 5 rows of trees, spaced 10 x 10 ft. apart. The soil is a sandy loam overlying gravel, which out-crops in places. It is a first-class agricultural soil and has, therefore, probably produced better results than could be expected from the average forest soil. It was cultivated before planting. The object of planting was to ascertain if eastern hardwoods are hardy in British Columbia. The matter was viewed and approached from the standpoint of a horticulturist, rather than from that of a forester.

No specific record was kept of what species were planted in the shelter belt, but the following are now to be observed :

	HARDWOODS
Black Walnut	(Juglans nigra Linn.)
Balsam Poplar	(Populus balsamifera Linn.)
White Birch	(Betula alba var papyrifera.)
Yellow Birch	(Betula lutea Michx.)
Purple Beech	(Fagus sp. ——.)
Chestnut	(Castanea dentata [Marsh.] Borkh.)
Oak	(Quercus robur. L.——)
Elm	(Ulmus americana Linn.)
Tulip	(Liriodendron tulipifera Linn.)
Sycamore	(Platanus occidentalis Linn.)
Cherry	(Prunus serotina Ehrh.)
Hard Maple	(Acer saccharum Marsh.)
Soft Maple	(Acer saccharum Linn.)
Norway Maple	(Acer platanoides.)
Basswood	(Tilia americana Linn.)
White Ash	(Fraxinus americana Linn.)
Catalpa	(Catalpa sp. ——.)
	SOFTWOODS
White pine	(Pinus strobus Linn.)
Jack Pine	(Pinus divaricata Ait.)
Scotch Pine	(Pinus sylvestris)
Mugho Pine	(Pinus Mugho)
European Larch	(Larix Europea)

The species in planting were apparently mixed promiscuously, with no regard to their respective qualities of tolerance, rapidity of growth, etc. Nearly all did well for a number of years until they began to crowd. Then the intolerant ones, with the exception of those individuals which managed to keep on top by rapid height growth, began to suffer from shading. To-day some of them are dead (noticeably nearly all the jack pine and many of the Scotch pine) and others

are dying. A deduction, therefore, of the suitability of the various species for planting in British Columbia based simply on a comparison of their present conditions in the shelter belt, would be manifestly unfair to the intolerant species. The probability seems, that, if properly planted in proper mixture, nearly all the above species would thrive.

The following species seemed especially promising :

Maples	Oak
Basswood	Black Cherry
Chestnut	Beech
Tulip	Sycamore
Yellow Birch	White Pine
White Ash	European Larch

The diameters (breast high) of these ranged from 6 in. to 14 in. and the heights approximately from 30 to 60 ft. In form development, the white pine, chestnut, and oak seemed best. A drawback to chestnut is the existence of chestnut blight which was reported from the farm in 1912. A Washington, D.C., expert who pronounced it blight said it was the first reported from Canada (a rather doubtful honour for British Columbia). Catalpa, walnut and all the pines except white pine were particularly unthrifty because of shading.

The second plantation was made in the falls of 1893 and 1894 on the side of the hill referred to above. The soil is thinner and rockier. The exposure is south-west. A natural forest already existed, so the planting was done in vacant and cleared places here and there. Both nuts and two-year-old trees were used, but no records exist as to the comparative results obtained from the two methods ; neither is it known how many were planted, nor where all the planting was done, and time did not permit of any extended search. The following were observed :

Walnut Hickory	up to 10 ft. high.
Oak Chestnut Yellow Birch White Birch	up to 25 ft. high.

All appeared to be flourishing.

The result of the Agassiz planting, then, as far as it goes, indicates that at least from a silvicultural standpoint, the introduction of exotic hardwoods into British Columbia is perfectly feasible.

At the Sidney farm no conclusive results are yet apparent. However, the fact that over 11,000 ornamental trees and shrubs, 1 to 3 years old, exotics from a large nursery in France, are planted in the nursery, indicates that those in charge have confidence in the ability of hardwoods to grow in British Columbia. Prof. J. Macoun, Sr., states that the sycamore seems to do especially well, and also that the English walnut and the filbert both thrive and fruit in the vicinity.

At Stadacona Park, in Victoria, a number of exotic trees may be seen, among which is the Norway spruce, all flourishing. Near the entrance, a row of trees affords interesting comparisons of natives and exotics. Here were planted in mixture, Douglas fir, European larch, giant red cedar and yellow birch. The trees are probably 25 to 30 years old. The Douglas fir is now 10 to 12 in. in diameter breast high, and, approximately 50 ft. in height. Its rapid growth has overtopped the birches, larches and cedars, to their detriment. The European larch is regarded as a rapid grower in Europe, but is evidently inferior to the Douglas fir in that respect. Such a conclusion would not be allowable from a single observation of such a character, but it is borne out by experiments which have been carried on in Europe.

2. *Financial Considerations.*—Any opinions with regard to the question of whether or not reforestation would be both practicable and profitable in British Columbia must necessarily be based upon the experiences of other countries. Fortunately reliable figures are obtainable from the Pacific States. The governing factors from a financial standpoint are the amount of initial investment, the annual carrying charges, the rate of interest, the length of rotation, the amount of yield and the stumpage prices to be expected. For several reasons, British Columbia is very favourably situated in regard to these factors.

The initial investment includes the value of the land and the cost of regeneration, including such protective measures as brush burning. In the United States, some of the States are buying land for reforestation at prices ranging from $2.00 to $10.00 per acre, and in Europe more is paid as a rule. This is for land, which, on the average, is much inferior to that of British Columbia for the production of forest crops. This initial outlay forms a serious hindrance to the rapidity of forestry development in the countries where it is necessary. Fortunately, the people of British Columbia have been wise enough to retain ownership of the bulk of their timber lands. Therefore, this

part of the initial outlay may be neglected, as far as the Government timberland is concerned. And for reasons already explained, the cost of regeneration is low. Five dollars per acre is ample allowance for both the cost of regeneration and the expense of brush-burning. Indeed, it is twice what is allowed in Circular 175, U.S. Forest Service, for similar conditions.

Annual carrying charges consist of taxes, and expenses of protection and administration. Like the land value, taxes may be neglected in dealing with Government land. Other expenses may be placed, for the present, at 5 cents per acre per year. The proper rate of interest to use for forestry calculations is a much debated point. In Europe where conditions are more stable and protection better assured, the business obtains a low rate of interest, 2½ per cent and 3 per cent, because of its long-time, safe character. Here, however, probably 5 per cent should be used, at least under present conditions.

The number of years and the amount of yield are co-related and depend chiefly on species, soil and climate. Here again, as already stated, British Columbia is exceptionally favoured. The U.S. Forest Service have estimated the growth rate for the Pacific forest to be twice the average for the United States. The following yield table for Douglas fir is taken from Circular 175, U.S. Forest Service. It was prepared from measurements taken by the U.S. Forest Service of practically pure fir on about 400 areas in 35 different age stands from 10 to 140 years old, ranging along the Western Cascade foothills from the Canadian line to Central Oregon. The areas were selected as average and typical of the better grade of the forest soil.

YIELD TABLE FOR DOUGLAS FIR

Age of Stand	Per Acre Feet, B.M.
40	12,400
50	28,000
60	41,000
70	51,700
80	61,100
90	70,200
100	79,800
110	90,300
120	101,500
130	113,000

Assuming that, under natural conditions, the forest requires an average of 5 years to become established, the above ages should be increased by five years each to get the correct performance, so that, for instance, a 55-year-old stand would yield 28,000 ft. B.M. and a 50-year stand 20,500 ft. B.M. per acre.

Future values of stumpage cannot be estimated nearly as exactly as can future growth. But decreasing world supplies and increasing demand will undoubtedly eventually push stumpage prices up to, and beyond, the cost of production of a timber crop. In the United States, between 1900 and 1907 the cost of stumpage rose 93 per cent, and it is still going up very rapidly. Douglas fir stumpage in the same period increased 87 per cent, and cedar 251 per cent. In view of the fact that Ontario white pine stumpage has recently sold for over $13.00 per M. ft. B.M., it is reasonable to suppose that Douglas fir stumpage in 60 years will be worth at least $6.00 per M. and will increase by 50 cents each decade after that.

A hypothetical case with the above data, 60-year rotation, works out per acre as follows :

Initial outlay $5.00, 60 years at 5 per cent compound interest	$ 93.40
Annual carrying charges 5 cents " " " .	17.68
Total Cost	$111.08
Returns 34,500 ft. B.M. at $6 per M. ft. B.M.	207.00
Net profit per acre	$ 95.92

Which is at the rate of $1.60 per year in addition to the return of 5 per cent on the investment.

For a 70-year rotation :

Returns 46,350 ft. at $6.50	$301.27
Costs $152.15+$29.43	181.58
Net profit per acre	$119.69

which is at the rate of $1.70 per acre per year.

For a rotation of 80 years the figures would be :

Returns 56,400 ft. B.M. at $7.0..0	$394.80
Costs $247.80+$48.56	296.36
Net profit per acre	$ 98.44

which is at the rate of $1.23 per year per acre.

Evidently from the above data, a 70-year rotation would be most profitable.

The above figures are purposely conservative. German forests under sustained yield produce net revenues of from 50 cents to over $5.00 per acre per year from land less productive than that of British Columbia, in a climate less favourable and with a heavier initial outlay in each rotation to ensure reproduction.

Though hardly pertinent to the subject, it is of interest to calculate the expectancy value of soil producing as above, using the well known formula :

$$Se = \frac{Yr + Ta\,(1.0\,p^{r-a}) + \ldots + Tq\,(1.0\,p^{r-q}) - c\,(1.0\,pr)}{1.0\,pr - 1} - \frac{e}{.0p}$$

For simplicity of calculation we may neglect the intermediate yields and assume data as above. For 60 year rotations the soil expectancy value is per acre :

$$Se = \frac{\$207 - 93.40}{17.68} - \frac{.05}{.05} = 5.43$$

In this connection, it is noted from the report of the British Columbia Forestry Commission, 1910, that the average assessed value per acre for Crown granted timberland on Vancouver Island, 1909, was $9.69, and for the mainland $6.41. Since this value includes the timber as well as the soil, it is far too low.

The commercial range of the Douglas fir west of the Cascades is approximately included in the Vancouver and Island forest districts which have an approximate total of 20,000,000 acres. Assuming one-fourth of this to be crown property, capable of producing as above, this would be worth $27,150,000. Of course, such calculations are based on estimates, but they are at least conservative estimates. Certainly, $5.43 per acre is not excessive for land as productive as that in question.

What the total value of timberland for the whole Province would be, based on the same method of calculation, it is difficult even to conjecture, but certainly it would be enormous. It may be guessed at in a simpler way. Assuming that the estimated 65,000,000 acres of timberland will some day produce at the rate of $1 per acre per year, there is an annuity of $65,000,000. The capital value of that at 5 per cent is $1,300,000,000 ; at 3 per cent is $2,166,666,666.66. The conclusion is that it is profitable to secure forest regeneration by aiding Nature, even if not by planting.

3. *Economic Considerations.*—It is possible and probably practicable to secure artificial reforestation in British Columbia, but is it desirable or necessary ? And if desirable, is it the most profitable way to use the money ?

Remembering that British Columbia has over half the standing merchantable timber of Canada ; that only one-fifth of the estimated annual growth is at present being cut ; and that there is an enormous

area to administer, as yet only very sparsely populated, it would seem that the rational and common sense policy—the one best suited to the conditions—is the very one which the Forest Branch are at present following. That is, to devote the chief attention to proper protection and utilization of the present crop. Such care is in any country the first consideration in connection with the production of a new crop. However, in at least a very large part of British Columbia, as has been stated, this is generally all that is necessary to ensure a new crop.

It may be concluded then that artificial reforestation is neither necessary nor, relatively speaking, desirable, over the major part of British Columbia to-day.

SUMMARY :

1. Forest planting in British Columbia is silviculturally possible. Hardwoods may be grown as well as softwoods.

2. Forest regeneration in British Columbia is financially practicable, and possibly also forest planting.

3. But forest planting is now, in general, neither necessary nor the most profitable way to spend time, energy, or money in British Columbia.

Planting in Alberta, Saskatchewan and Manitoba

A very large percentage of the land in the accessible portions of these three provinces is treeless and chiefly valuable for agriculture. Aside from the relatively small areas of forest reserves east of the Rocky mountains, the question of planting relates therefore principally to the farming sections. Here, land values are too high to justify the use of large areas of cultivable lands for commercial tree planting. Also, climatic conditions are unfavourable to this class of investment on a large scale. The high winds cause excessive evaporation, which in turn tends to prevent the ideal height growth which would be a large factor in a commercial tree-growing enterprise.

Again, the relative dryness of the climate and the extremes of temperature, besides making for relatively slow growth, greatly limit the choice of species suitable for prairie planting, so that the range of choice is limited for the most part to species that are not regarded as particularly suitable for the production of lumber.

Another factor is the relatively high cost of establishing a forest plantation, for commercial purposes, on the prairies,—where the natural conditions are unfavourable,—as compared with the cost of bringing lumber from the virgin forest, or even of establishing a new forest at

a distance on low-priced, non-agricultural lands which have in the past supported a forest growth, and where the natural conditions are favourable.

For these reasons, prairie planting can, as a rule, be expected to be carried on only on a small or moderate scale, as an adjunct to farming operations, and where the incidental benefits are chiefly considered, rather than the commercial value of the timber itself.

Protection of the forest cover is urged on the mountain watersheds, in order to protect the soil of the mountains from erosion and the soil of the low-lands from being borne away by floods, which would follow the denudation of the mountain slopes. However, floods are not the only agency which bring about the erosion of valuable farming lands. Experience has already shown that, in the prairie provinces, where cultivation has extended over considerable areas, the strong prevailing winds cause drifting of the soil. This is a form of sheet-erosion, and causes great damage to standing crops, besides decreasing the capacity of the land to produce future crops, since the upper layer of the soil is most fertile. To meet this situation, the planting of trees as windbreaks is essential.

The breaking of the wind will decrease the evaporation of moisture from the soil for a considerable distance on the leeward side from the prevailing winds. As a result, growing crops will be materially protected ; and will make a better growth than would otherwise be possible. This has been found to apply particularly to orchards, where the beneficial effects of windbreak protection are truly surprising. By planting a series of wind-breaks through a period of years, the entire farm may be safeguarded, and at the same time a perpetual source of wood supplies will be ensured for farm use as well as a source of revenue from sales.

The planting of windbreaks will tend to prevent snow blowing off the land in winter, and thus, by insuring a greater supply of soil-moisture will bring about better crops. Not only this, but, by properly locating the plantations, protection will be afforded farm-buildings and live-stock, thus reducing fuel and feed bills. It unquestionably takes more grain to produce a pound of flesh upon animals exposed to the cold winds of winter than upon stock that is protected from blizzards. In summer, the trees will likewise afford shade and protection.

Aside from all the above, the presence of groves of trees upon a prairie farm renders the place more attractive and comfortable, and adds materially to its desirability and sale value. The added value on this account has been estimated as high as $1,000 per acre of plantation.

COTTONWOOD AS A FUEL PRODUCER
Three and one half cords of wood cut from trees four years after planting

WINDBREAK OF COTTONWOOD, TWELVE YEARS OLD FROM CUTTINGS

In the Prairie Provinces, the principal incentive to tree planting has been the activity of the Forestry Branch, Department of the Interior. The following statement regarding this work has been prepared by Mr. R. H. Campbell, Director of Forestry.

Work of the Dominion Forestry Branch

Farm Planting.—Tree planting on the farms in the prairie districts of Manitoba, Saskatchewan and Alberta, was begun in the year 1901 when the use of a small piece of land at the Experimental Farm at Brandon and at the Experimental Farm at Indian Head was obtained, and a distribution of 58,800 trees was made in that year. The number of trees sent out each year has grown steadily, the distribution in 1912 being 2,729,135, or a total of 21,650,660 for the years from 1901 to 1912 inclusive. The number of persons supplied with trees increased from eleven in 1901 to 3,618 in 1912.

The trees are supplied for planting on farms for shelter belts and woodlot purposes and are not supplied for planting for ornamental purposes.

The trees are supplied only after the applicant has signed an agreement to care for the trees in accordance with the instructions of the Department, these instructions being in regard to the handling of the stock, the planting of it, and especially the proper cultivation of the soil before planting and for two years after planting.

The inspectors, who have had training in nursery work, are appointed to visit the farms of the applicants, advise them as to the location and arrangement of their shelter belts and the species of trees best suited to the conditions, and to report as to the trees which should be sent to the applicant if it is found that his land is in proper condition. After the trees have been sent out the inspector again visits the land to see that they have been properly planted and cultivated. As a result of this careful inspection it has been found that the average of success throughout the prairie country was from 85 to 90 per cent.

Up to 1911 only hardy and deciduous species of trees were distributed, the principal species being Manitoba maple, elm, ash, cottonwood, willow, and Russian poplar. In 1911 a beginning was made in the distribution of coniferous trees, a stock of such trees having been worked up in the nursery. The species of coniferous trees distributed were white spruce, Scotch pine and tamarack.

The deciduous trees have been distributed free of cost, but for the coniferous trees a charge of $1.00 per hundred is made, it being im-

possible with the conditions under which we are working to work up a large supply of coniferous trees.

Forest Reserves.—In the forest reserves only a small beginning has been made in reforestation work, although a little experimentation has been done. On the Spruce Woods Forest Reserve, which is a bare, sandy tract, and on the Turtle Mountain Forest Reserve, which is a fairly heavy clay loam, experiments have been made in seeding, the species used being white spruce, jack pine, and western yellow pine. On the Spruce Woods Forest Reserve the attempts at re-seeding were almost completely a failure, although all methods were tried, except in a few places where there was already some shelter from small bluffs of poplar. On the Turtle Mountain Forest Reserve the seeding in seed spots was, on the whole, a fair success, and we have about an acre fully stocked with Scotch pine and spruce from this seeding experiment on Turtle mountain.

The planting of nursery stock was also tried for several years on the Spruce Woods Forest Reserve, the stock used being Scotch pine. The number of trees planted in this experimental plantation was 75,000 plants of one and two years old, mostly all two years old. The first plantation of 5,000 was made in 1904 but owing to the carelessness of the ranger in charge these trees were destroyed by fire. Of the remainder from 60 to 80 per cent are living, the total of trees now alive being 50,200. This plantation was made in furrows run from east to west, throwing the furrow to the south side, thus giving the small plants shelter from the sun in the morning. This plantation has been successful enough to demonstrate that this method could be used satisfactorily.

Having come to the conclusion that the only method of reforesting the Spruce Woods Forest Reserve was to replant, and that in consequence a nursery should be established and extended on the reserve as rapidly as possible, it was arranged to appoint in charge of this work Mr. J. D. Kirkwood, who had had a good training in forest nurseries in Scotland. Mr. Kirkwood has prepared a nursery at Shilo on the west end of the reserve, on a tract which is entirely denuded of trees, and has now a stock of 230,000 trees, consisting of 3,000 three-year olds, 75,000 two-year-olds and 152,000 one-year-olds. These trees consist principally of white spruce and jack pine, but there are also experimental plots of lodge pole pine, western yellow pine and black spruce.

On the Turtle Mountain Forest Reserve, 14,000 trees, nearly all Scotch pine, supplied from the forest nursery station at Indian Head, were set out as an experimental plantation, and so far the report is that this plantation is doing satisfactorily.

MAPLES IN PRAIRIE SECTION, PLANTED ALONG RIGHT-OF-WAY OF CANADIAN PACIFIC RAILWAY TO PROTECT TRACK FROM DRIFTING SNOW

WILLOWS ALONG RIGHT-OF-WAY ON THE PRAIRIES

Seven thousand five hundred trees from the nursery at Indian Head were also set out on the Riding Mountain Forest Reserve at two places, as experimental plantations, and have been doing very well during the present year. Planting has not yet been considered necessary in the Rocky Mountains Forest Reserve, on account of the most excellent natural reproduction.

Forest Planting by the Canadian Pacific Railway*

The planting work done by this Company has been mainly confined to ornamental planting on station grounds, and the planting of trees along certain portions of the right of way in prairie sections. The object of the latter is to form windbreaks and thus do away with the necessity for maintaining portable snow fences, the erection of which has previously been necessary in order to prevent the drifting of snow upon the track, and consequent interference with train traffic. Considerable progress in this work has been made by the Company's Forestry Branch, Department of Natural Resources.

Along the main line between Winnipeg, Man., and Calgary, Alta., 1,356,200 trees had been planted up to December, 1912. These trees were grown in the Company's nursery at Wolseley, Sask. The species planted are Manitoba maple, Russian poplar, cottonwood, laurel leaf willow, red willow, golden willow, ash and spruce. Two species of shrubs were also planted, caragana and artemisia. All trees were two or three year old transplants, varying from thirty to fifty inches in height. The loss and renewal has not exceeded ten per cent. The trees were planted four feet apart in the rows and seven feet between the rows, leaving a cultivated strip eight feet wide around the plantation.

A plantation of 25,000 tamarack was planted in the spring of 1908, near Wolseley, Sask. The object of this plantation was to determine the feasibility of growing tamarack for fence posts and ties on waste prairie land. Of this plantation, about 1,000 trees died the first year. During 1910, 200 more died on account of late spring frosts, and there are at present 23,800 tamarack in the plantation. The following are the average of a number of measurements taken each year :

Year	Height	Growth	Diameter in ins. 18 in. above ground
1910	5 ft. 8 in.	1 ft. 7 in.	.85
1911	7 ft. 2 in.	1 ft. 4 in.	1.25
1912	9 ft. 0 in.	1 ft. 8 in.	1.50

*Prepared from a statement by R. D. Prettie, Superintendent of Forestry, C.P.R. Department of Natural Resources.

More recently, a definite policy has been adopted of encouraging tree planting on irrigated lands purchased from the Company by settlers in southern Alberta. The Company offers to supply, free of charge, half of the trees required, and offers prizes for the best showing made.

Forest Planting in Ontario *

There are in Ontario two classes of lands which should be permanently managed for forest crops. These are, first, the small isolated patches of non-agricultural soils to be found throughout otherwise good farm lands ; and, second, the large contiguous areas of non-agricultural soils which exist in many parts of the Province. It is estimated that there is, in the old settled portion of Ontario, (south of the Ottawa river) an aggregate of about 8,500 square miles of farmers' woodlands. It is safe to say that there is, in addition to the assessed woodlands, another area of 8,500 square miles which is suited only for forest growth.†

To assist and encourage the private owner of such lands to plant them to forest trees, the Provincial Department of Agriculture has embarked on a definite and extensive plan of co-operation. The Department undertakes, so far as the means at its disposal will permit, to assist in the growing of a forest plantation or woodlot, by directing through one of its officers as to preparation of soil, varieties to plant and manner of planting, and as to care after planting. The Department also endeavours to furnish seedling trees or cuttings, as plant material free of charge, up to the amount required to plant two acres for any individual during one season.

The owner on his part, must prepare the soil, plant and care for the trees, and do all the actual work in connection with the plantations, in accordance with the directions of the Department. Planting is especially encouraged on such waste portions of the farm as steep hillsides, light sandy, rocky, or gravelly spots, swamp lands and portions of farm cut off by streams or otherwise. However, in certain localities without woodlands, it may be found advisable to plant on good agricultural soil, if the owner so desires.

The work of tree distribution was first started in 1906, along the above lines. Nearly one and a half million trees have been distributed since that time. During 1912, 375,000 plants were distributed,—

* Prepared from official publications of the Ontario Department of Agriculture and from a statement by E. J. Zavitz, Provincial Forester.

† Report on the Reforestation of waste lands in Southern Ontario, by E. J Zavitz, Department of Agriculture, 1908.

A PINE NURSERY AT THE NORFOLK FOREST STATION

chiefly evergreens, such as white pine and Scotch pine. This planting has been chiefly on waste tracts of soil, such as sand formations. The plantations are usually from one to several acres in size, although, at the forest station in Norfolk county, large areas are planted, and, in two or three cases such as the Guelph City watershed, there are about sixty acres planted. The plantations are located in forty-two counties, but the greater portion of the planting has been done in Southwestern Ontario.

The Forest Station in Norfolk county, where the nurseries are located, was started in 1909. This station now contains 1,500 acres, and should be still further increased. The land at this Station contains second-growth pine, scrub oak lands, abandoned fields, and blow sand formations, thus affording a variety of conditions with which to deal in an experimental way. At the Station there are now about 100 acres of experimental plantations, and the nurseries contain one and a half million plants in seed beds and nursery lines, for future planting. The work at this Station contributes an element in the forestry instruction given the students of the Faculty of Forestry, University of Toronto.

The policy can not be too strongly urged of preventing, so far as possible, the settlement of waste lands. Settlement has, unfortunately, already taken place on considerable areas of such lands in Southern Ontario, and the evil effects are only too plainly apparent in the increasing poverty and degeneracy of the population. The Province, as a whole, can not afford to perpetuate such a condition, and such areas should be withdrawn from settlement, established settlers should be transferred, and the lands should be permanently devoted to forestry purposes. Recurrent fires have so completely destroyed seed trees of valuable species over large areas of these lands that planting will be necessary in order to re-establish the forest. It is truly said by the Provincial Forester, Mr. E. J. Zavitz, that the only solution of this waste land problem is in the adoption of a policy, which shall have as its aim the gradual segregation of these areas, to be permanently managed as forest lands by some Government agency. The principal responsibility most naturally falls upon the Provincial Government, though under some circumstances, the co-operation of the Dominion Government might be justified.

Similarly, the problem can no doubt be solved in part by the adoption of a progressive policy by the municipalities. Provision for this procedure was made through the enactment of "The Counties Reforestation Act" passed by the Provincial Parliament, March 24th, 1911, (Chapter 74 of 1st, George V., 1911). This legislation was passed

upon the representations of the County Council of the County of Hastings. The Act is general in its nature and provides under certain conditions for the passage of by-laws by the municipal council of any County for acquiring by purchase, lease or otherwise, lands determined suitable for reforestation purposes. Provision is also made for forest planting and for preserving and protecting the timber on such lands. Authority is also granted for the issuance of debentures for the purchase of such lands to an amount not exceeding $25,000.00 to be owing at any one time.

Under this Act the County Council of Hastings county has through its forestry committee secured the purchase of 2,200 acres of cut-over lands in Grimthorpe township at the rate of 17c. per acre, for non-payment of taxes. The purchase of additional areas of cut-over lands is contemplated. Fire protection and natural re-stocking from remaining seed trees will, for the present at least, form the principal features of the forestry policy of the County in handling these lands. It is, however, probable, that planting will become practicable at some later date. The Council of Peterborough county has more recently established a forestry committee to consider action along lines similar to that taken in Hastings county.

Forest Planting in Quebec

I. By the Provincial Government*

The Department of Lands and Forests has since 1908 conducted a nursery at Berthierville, where on a farm belonging to the Department 30 acres is devoted to forestry purposes. Of this, 23 acres is in woodland, and 3 in nursery. This tract is used also in furnishing instruction on planting operations to the students of the Forestry Department at Laval University.

The Berthierville nursery is intended to furnish the plants required for the reforestation of 15,000 acres of moving sands in Argenteuil county, which have been denuded by reckless lumbering, and which have so deteriorated that they threaten the total destruction of a number of valuable farms in the neighbourhood.

The Department has purchased from several farmers at Lachute about 350 acres of shifting sands at a cost of $1.00 per acre, with the agreement that the former owners may within 15 years repurchase their

*Prepared from Report of the Minister of Lands and Forests, and from statements by Mr. G. C. Piché, Forester to the Department.

ELEVEN YEAR OLD SCOTCH PINE PLANTATION, N.Y. STATE LANDS NEAR LAKE CLEAR JUNCTION, ADIRONDACK PRESERVE

SCOTCH PINE PLANTATION, COLLEGE TRACT, AXTON, ADIRONDACKS PRESERVE.
Trees about 15 years old

holdings by paying back the cost of the land and reforestation, together with accrued interest at 4 per cent. The Department, however, guarantees that the total cost to the former owners shall not exceed $10.00 per acre, the surplus, if any, being the contribution of the Government to the work.

The work of planting was started in May, 1912, and 25 acres was reforested to white pine, white spruce, elm and green ash. The sand, while dry at the surface, is moist at a depth of three inches, so that conditions are quite favourable for planting.

The Department expects to follow a similar course with regard to other areas of sand waste in the Province, particularly around Berthier, Contrecoeur and Tadoussac. It is not the intention that the Department shall reforest all these areas, but the aim is, rather, to demonstrate the possibilities and thus encourage action of a similar nature by private initiative on the part of the land owners. It is hoped that in this way the encroachments of the shifting sands upon agricultural lands will be checked, as has been successfully done in the case of the historic example set by the French Government in the Landes. A part of the plant material in the Berthierville nursery is to be used for distribution among farmers desiring to make plantations on their lands.

Like the Province of Ontario, Quebec has considerable areas of land which ought never to have been cleared. Some of the lands taken up in the early days have been abandoned because it was impossible to make a living upon them. In some cases, these lands still have a certain amount of timber left upon them. Other non-agricultural lands were never taken up, but were cut-over from time to time, and still remain in the ownership of the Province. To utilize these two classes of lands and to make them contribute to the local public welfare, a plan of township forest reserves has been devised, whereby all such vacant non-agricultural lands in a given township are merged together and withheld from further disposal.

The farmers or settlers of the surrounding parishes are allowed to cut timber in these reserves on the following terms : Each year only one-twentieth of the area is opened up to them ; no permit can be given for more than 10,000 feet B.M. ; the permittees must cut where and how directed by the warden of the reserve ; they must pay one-half of the dues on taking the permit and the balance when they have cut their timber, which must be piled and is measured by the wardens of the Department. The cutting is directed by a diameter limit the same as on Crown Lands, and the dues are fixed at the same rate.

Thus there are being created in the neighbourhood of each village little forests aggregating from 2,000 to 15,000 acres, more or less in blocks, where the farmers can cut each year enough timber for their real wants.

There are now eight such reserves established covering 125,000 acres and plans have been made to establish twelve more, which will bring the area under township reserves to over 250,000 acres. Three were under operation in 1912 and produced good results. This year the Department will begin to make an inventory of at least 5 of these, so as to prepare a working plan for each.

It is the intention to establish each reserve upon a sound basis by building a good system of roads and trails, by providing it with a main system of telephone lines, observation towers, and houses for the wardens. The parts denuded will be reforested, but not immediately. The reproduction is so good in Quebec that wherever fire can be kept from reappearing periodically, the land will soon be clothed with some kind of forest growth, generally birch and aspen. The present plan is to allow this first covering to establish itself, help it in certain cases, then introduce plants of more desirable species, in openings made artificially or naturally.

II. Planting by the Laurentide Company*

The Laurentide Company of Grand'Mere, Quebec, has been experimenting for the past five years in planting trees and has now over fifty acres planted in different locations and under different conditions. There are Scotch, white and jack pine, nine years old ; the Scotch pine between five and six feet high, and the jack pine five to eight feet high ; the white pine has not done so well and ranges from three to four feet. Plantations of white and Norway spruce have been made in the open and also under old hardwoods, so that the results may be studied.

A nursery has also been started and has the following growing stock :

11,000	3 year	Norway spruce
1,000	2 year	" "
25,000	1 year	" "
20,000	1 year	red pine
5,000	1 year	white pine
5,000	1 year	jack pine

*Prepared by Ellwood Wilson, Forester for the Laurentide Co., Ltd.

10,000 1 year white spruce
10,000 1 year hemlock

Basswood has also been planted.

This Company expects to have a production from its nursery of about 200,000 trees per year, and will continue its experiments with other foreign conifers and also plant various hardwoods, chiefly to supply its Landscape Department with ornamental trees.

Waste lands now owned by the Company are being planted and this work will be carried out on a much larger scale. The object of this work is to produce a supply of wood material, to be used in the manufacture of pulp and paper in the Company's plant at Grand'Mere, supplementing the extensive areas of virgin forest on the Company's timber limits on the St. Maurice river.

The Forestry Department has a farm of two hundred acres, about one-third covered with hemlock and hardwood, which will be cut according to various silvicultural methods, and the cleared land will be planted with the species best suited to the soil.

A tract of four square miles is about to be acquired for silvicultural experimental work, where the effect of different methods of cutting can be studied on a large scale.

So far, Norway spruce has shown itself a very satisfactory tree. The three-year-old stock, seedling, averages nine to ten inches in height, the three-year-old transplants about seven inches, and the one-year-old seedlings about four inches. The growth is much more rapid than that of the white spruce and the trees more vigorous. The Norway spruce set out in plantations has a much smaller percentage of loss than the white spruce and grows better both in the open and when underplanted.

Forest Planting in the Maritime Provinces

On account of the excellent natural reproduction which generally follows lumbering operations and fires, the necessity for artificial planting has not made itself strongly felt in the provinces of New Brunswick and Nova Scotia. This situation is emphasized by the fact that cut-over lands well stocked with young growth can be purchased at a less cost per acre than would be required to restock artificially. It is probable also that a large percentage of the farms are either partially in woodland or are sufficiently close to forest areas, so that the need for home-grown wood supplies has not yet been felt to a material extent. The Provincial Governments have accordingly not as yet undertaken a definite campaign for the encouragement of tree-planting.

Undoubtedly, however, planting is desirable under some conditions, although the need is much greater at the present time for adequate

expert instruction as to better methods of handling the existing forest areas in private ownership. In Nova Scotia, the need along this line is particularly urgent, since all but a very small percentage of the forest land has passed from the ownership and control of the Provincial Government. In New Brunswick, the privately-owned lands comprise a much smaller percentage, and the problem is more particularly one to be solved through the imposition of regulations for the cutting of timber on crown lands. Considerable study has already been devoted to this subject, although the Provincial Government has not yet employed a trained forester in an administrative capacity.

Notwithstanding the temporary situation above outlined, several small beginnings have been made in forest planting through the initiative of private owners. With the advice and assistance of Prof. R. B. Miller of the Department of Forestry, University of New Brunswick, a plantation of about fifteen acres of white pine has been made on the lands of Dr. A. R. Myers of Moncton, N.B., and about the same area of Norway spruce was planted on the lands of the Rhodes-Curry Co., in Nova Scotia, near Amherst, N.B.

The Myers plantation is about thirteen miles from Moncton and, so far as known, represents the first attempt at forest planting in New Brunswick. This planting was done in 1911. The field had previously been ploughed and harrowed, and the two-year-old trees were set out five feet apart. The results of this work are reported as being very satisfactory.

The Rhodes-Curry Co., of Little River, N.S., desired to ascertain the practicability of reforesting its very considerable areas of burned-over lands, and, in the spring of 1912, selected a small tract for experimental planting. The site chosen was a hill which had been burned over and was being poorly restocked with fir, spruce, and red pine, from the few remaining seed trees. The brush, rotten logs, and other inflammable débris was first removed, and the area was then fenced to keep out deer. Three-year old Norway spruce seedlings were planted.

On the lands of the Pejepscot Paper Co., at Salmon River, N.B., a small nursery has been established since 1911. A similar small nursery is situated on the lands of this Company at Cookshire, Quebec. These nurseries are for purely experimental purposes, in order to determine the practicability of planting up the large areas of burned-over non-agricultural land belonging to the Company, which are not restocking naturally to a satisfactory extent.

No steps have yet been taken in the direction of forest planting by the Government of Prince Edward Island ; and no information is available as to work done by private owners.

Part VI

Report of the Committee on Forests, Commission of Conservation, 1912

(Presented at Annual Meeting at Ottawa)

Undoubtedly, the two most important accomplishments of the Commission of Conservation along forestry lines in the past, have been the establishment of the Rocky Mountains Forest Reserve and the Government control of the railway fire situation through the amendment of the Railway Act and the issuance of appropriate regulations by the Board of Railway Commissioners.

Aside from the forest survey in Peterborough and Haliburton counties, Ontario, carried on last summer under the direction of Dr. B. E. Fernow, and the conclusion of a study of forest taxation in Canada by Mr. A. Donnell, the principal activities of the Committee on Forests during the past year have been in connection with the various phases of the forest fire problem. The Forester for this Commission was also appointed Chief Fire Inspector for the Railway Commission, and his chief efforts have necessarily been in connection with the field organization of the railway fire work. However, some of the general phases of forestry work have been considered and are covered in the following report. For convenience of discussion and consideration, the report has been divided into several separate sections, as indicated.

The Railway Fire Situation

1. Lines Subject to the Railway Commission

The issuing of Order No. 16,570, by the Board of Railway Commissioners, May 22nd, 1912, was the beginning of a new era in railway fire protection in Canada.

The origin of this action was the request made in 1909 by the Government of British Columbia that provision be made by the Board for the prevention of forest fires along railway lines in that Province, in addition to the existing requirements for the use of fire-protective appliances on locomotives, which, while essential, were not wholly adequate.

The New Legislation

Largely through the influence of the Commission of Conservation, legislation was secured in 1911 authorizing the requirement of patrols by railway employees; and the Commission was also largely instrumental in drafting and securing the final issuance of Order 16,570.

In addition to the enforced use of fire-protective appliances on locomotives, the non-use of lignite coal, and the construction of fire-guards, contained in previous Orders, the new Order provided for special patrols by railway employees, the inclusion of the whole field force of railway employees in the fire-protective organization, the regulation of the burning of inflammable material along rights-of-way and the extension of the Order to cover the construction as well as the operating period.

This Order goes further in placing upon the railway companies themselves, where it belongs, the responsibility for preventing fires along their lines, than does any similar legislation in the United States or Canada; and it may therefore be said with propriety that Canada has, in this respect, assumed a distinctly leading position on this continent. As to lines in Canada not subject to the jurisdiction of the Board, the requirements imposed upon railway companies as to fire-protective measures are distinctly more progressive in British Columbia, Ontario and Quebec than in the other Provinces.

Late in May, the Forester of this Commission was appointed Chief Fire Inspector for the Board, in pursuance of a co-operative arrangement between Hon. Mr. Sifton and the late Chief Commissioner Mabee.

Organizing the Field Force

The organization of the railway fire work was immediately taken up. Conferences were held with railway officials in the West, and with representatives of the Department of Lands, of British Columbia and of the Forestry and Parks Branches, Department of the Interior. Letters of instruction were then issued by the Chief Fire Inspector to the various railway companies in British Columbia, Alberta, Saskatchewan and Manitoba, prescribing the measures to be taken by each for the prevention and control of fires during the balance of the fire season.

In order to insure proper enforcement of the various requirements, arrangements were made whereby certain officials of the British Columbia Forest Branch and of the Dominion Forestry and Parks Branches were appointed fire inspectors by the Board of Railway Commissioners. These field inspectors were given authority to modify the requirements according to local needs, thus ensuring adequate protection at a mini-

mum of cost to the railway companies. In some cases, these men devoted their whole time to the work, while, in others, the fire inspection was handled as a part of their regular duties.

Some delays were caused by difficulty on the part of the railway companies in securing extra equipment and men, while, in some cases, the patrols prescribed proved not to be needed on account of phenomenally wet weather. The plan worked out very satisfactorily. The last half of the fire season proved unusually wet, so that fire losses were exceedingly light, and the efficiency of the newly-formed organization was not unduly strained. With the better organization that will be available, the work will be handled in a very efficient way during the season of 1913.

Fire Guards

The requirements as to the construction of fire-guards were practically the same as in previous years, with the exception that guards were required in Manitoba in addition to Alberta and Saskatchewan. The Chief Fire Guardian of the Department of Agriculture of Alberta was appointed Fire Guard Inspector for that Province and a similar plan is proposed for Saskatchewan. A study of the fire-guard situation is now being carried on, in the hope of making the requirements for next year correspond as closely as possible to local conditions, at a minimum of cost to the railway companies and of loss and inconvenience to land owners.

Cleaning Rights-of-Way

Much was also accomplished through close inspection in securing compliance with Section 297 of the Railway Act, which requires the destruction of inflammable material along rights-of-way.

Oil-Burning Locomotives

The use of oil-burning locomotives on the main line of the Canadian Pacific railway between Kamloops and Field, and on the main line of the Great Northern railway south and southeast from Vancouver, has enormously decreased the fire danger in those portions of British Columbia. The further extension of the use of fuel oil is greatly to be desired in this connection.

Organization in the East

After the work was organized in the West, it was too late to organize in the East for the small remaining portion of the fire season of 1912. The matter of co-operation has, however, been taken up by the Board with the Governments of the Provinces of Ontario, Quebec, New Brunswick and Nova Scotia. In some cases, the plan of co-operation has been confirmed promptly by the provincial government, while in others action has been more slow, especially with regard to the designation of the official to be appointed Provincial Fire Inspector. A number of subordinate

inspectors will also be needed in Ontario, Quebec and New Brunswick, to assist the Provincial Fire Inspector in handling the details of the work in the field. However, it is believed that the organization will ultimately be completed and that the provisions of the Order regarding patrols will be extended to cover the entire Dominion during the fire season of 1913.

2. Lines not Subject to the Railway Commission

Government Railways

In order properly to supplement the protection possible under Order 16,570 as to lines under the jurisdiction of the Board, it is recommended as to lines not so subject, that the Intercolonial and National Transcontinental railways organize a fire-protective service along the lines of Order 16,570. While some fire-protection work has been done, it has not been enough, and the burden of responsibility as to patrol has been too much thrown upon the provincial authorities. Through the Railway Act and the issuance of Order 16,570, the Dominion Government is committed to the distinctly progressive policy of requiring railways to handle the fire situation along their own lines. It is only logical that the Government-owned railways should set a good example in this regard.

Provincially Chartered Railways

In the various provinces, the situation as to provincially chartered railways is as follows :

New Brunswick.—In New Brunswick, an amendment of 1911, provides that each railway company, upon being notified by the Surveyor General, shall, between May 1st and December 1st of each year, provide a motor speeder, to be manned by at least three men, to patrol fifteen minutes after each train running through forest country, the particular portion of the railway line to be so patrolled to be designated by the Surveyor General ; and the cost of such patrol to be borne by the railway company. This requirement is somewhat more non-elastic than seems wholly desirable, and it is believed that its efficiency would be increased were the Surveyor General given full discretion as to the kind of patrol and the time when it should be required. In other words, pattern might well be taken from the general features of Order 16,570. However, the enforcement of the law as it stands should effectually prevent fires along provincially chartered lines. The essential, at the present time, is the formation of a special organization to handle all lines of forest fire work throughout the Province. It is understood that the Government now has this matter under consideration.

Nova Scotia.—In Nova Scotia, the Halifax and Southwestern railway is the only line along which there is any serious fire danger

that is subject to the jurisdiction of the Province. The railway authorities have voluntarily co-operated to a considerable extent in preventing fire damage, but it is believed that this situation should be definitely taken in hand through legislation, as in the other Provinces.

Quebec.—In Quebec, this matter has been handled through the issuance by the Provincial Public Utilities Commission of an Order almost identical with Order 16,570 of the Board of Railway Commissioners.

Ontario.—The situation in Ontario appears to be satisfactorily provided for through a provincial act authorizing the placing of fire rangers along the railway lines and charging the expense to the companies concerned.

Prairie Provinces.—In Manitoba, Saskatchewan and Alberta, very nearly all lines are subject to the jurisdiction of the Board.

British Columbia.—In British Columbia, the situation is covered by the Provincial Forest Act of 1912, which gives to the Minister of Lands ample discretionary authority as to railway fire protection.

The situation as to provincially chartered lines is really not so serious as might at first appear, since the mileage of such lines not subject to the Railway Commission comprises but a very small percentage of the total railway mileage of Canada. However, the matter deserves further attention in some of the Provinces.

Brush Disposal

There has been much discussion as to the disposal of brush from lumbering operations, but comparatively little definite action has yet been taken in Canada, except on paper. The slash menace is undoubtedly the most serious problem in connection with efficient fire protection.

In meeting this problem, the newly-established forest policy of British Columbia is the most progressive in Canada, since full discretionary authority is given the Minister of Lands in prescribing the measures to be taken, and efficient enforcement is provided through the organization of a fully-equipped Forest Branch.

In the issuance of all future licenses and in the renewal of the existing licenses, the Dominion and Provincial Governments should, in addition to seeing that reproduction is assured, take more fully into consideration the prevention of fires through proper brush disposal. In many cases, the present difficulty is not so much a lack of legislation or regulations as of suitable administrative machinery on the ground

for the enforcement of existing provisions. More complete provision should therefore be made for the proper enforcement of such requirements through an increase in the forest staff and by raising the standard of personnel through the general adoption of the merit system of appointment and promotion.

In order to make properly effective the measures which the railways are required to take for the prevention of fire along their lines, provision is especially needed for the proper disposal of slash along all railways through forest country. It is essential that existing inflammable material be removed along a wide strip outside the right-of-way, and that this action be made a fundamental requirement in connection with the issuance or renewal of timber licenses in the future. The same precautions should be observed wherever wagon roads run through forest sections.

Co-operative Fire Protection

One of the most encouraging signs during the past year in connection with better fire protection in the east, has been the organization of the St. Maurice Forest Protective Association. This Association is composed of limit-holders in the St. Maurice valley, Que. A manager, three inspectors and 50 rangers for patrol work were employed during the past season. As a result, while 97 fires were extinguished, only one attained proportions of any consequence, and this was in an old cutting. In addition to patrol, a start has been made in the construction of permanent improvements such as trails, telephone lines and look-out stations. The cost is met by an assessment upon limit-holders in proportion to acreage, aided by a contribution from the Quebec Government, in consideration of the protection of provincial property. It is to be hoped that the activity of this association will be extended, and that others will be formed. Most efficient results have been accomplished in a similar way through the formation of lumbermen's co-operative associations in the states of the Pacific Northwest.

Forest Surveys and Fire Statistics

Provincial Forest Surveys

It is essential to the preparation and adoption of any intelligent plan of forest management to know first in a general way, what are the conditions to be met. In this connection, the great importance of a general stock-taking to determine the extent and location of the forest resources of Canada, should be emphasized. A false sense of security has prevailed in the past, due to the general belief in the existence of forest resources very much greater in extent than now appear to exist. A forest survey of the entire Dominion would be a tremendous task for the Commission

of Conservation to undertake directly ; it would require years of effort, the building up of a large organization and the appropriation of a very large sum of money. Nor should it be necessary to handle the situation in this way. The Province of Nova Scotia has completed such a survey, the work having been done during the summers of 1909 and 1910 under the direction of Dr. B. E. Fernow. The Forest Branch of the Department of Lands of British Columbia has already begun a forest survey of that Province. It is most logical that this class of work should be handled through action by the local organizations, and it is recommended that this Commission urge action along this line. In Alberta, Saskatchewan and Manitoba the work should be handled through the Forestry Branch, Department of the Interior. In Ontario and Quebec, the work of the existing forestry organizations might be extended, while in New Brunswick the work could be handled under the direction of the Surveyor General.

Fire Loss Statistics

It is recommended further that this Commission urge upon the various Governments concerned the systematic collection of complete statistics of forest fire losses. In many cases the data collected in the past have been so incomplete as to be almost valueless. There is a very noticeable lack of information as to acreage covered by fires, and the amount and value of timber and other property destroyed. Such statistics are essential in order to determine the efficiency of fire-protective measures in effect, and to serve as a basis for improvement.

Reserve Extension in Northern Ontario

Non-Agricultural Lands

A brief preliminary reconnaissance of a portion of Northern Ontario was made last summer for the Commission by Mr. J. H. White of the Faculty of Forestry of Toronto University.* This examination shows that a large percentage of Ontario west of Sudbury and south of the Height-of-Land is non-agricultural and is valuable only for the production of timber. Fires have done enormous damage, especially during the period of railway construction. However, a great deal of valuable young growth has come in which requires protection that it may reach maturity. Some merchantable timber which has not yet been included in forest reserves or in timber limits, yet remains in regions back from the railways.

A Possible Reserve

Ultimately, the whole territory south of the Clay Belt, and lying between the Timagami and Nipigon reserves should be included in permanent forest reserves and protected and administered under forestry principles. This

*For report in full, see appendix, p. 156 *et seq.*

section will unquestionably prove a source of large revenue to the Province in the future. However, the area is so large and the immediate possibilities for revenue so limited that it seems doubtful whether reservation would be considered justified at the present time by the Provincial authorities, in view of the very large expense involved.

It is, therefore, recommended that if possible, an arrangement with the Provincial Government be made for a co-operative examination next summer of a portion of this region, for the purpose of securing more detailed information as to just what action it is most important and most practicable to take in the matter.

Dominion Forest Reserve Extension

During 1911, the Commission of Conservation took an active interest in the establishment of the Rocky Mountains Forest reserve, and assisted materially in securing the large addition which increased the area of Dominion forest reserves from less than 3,000 square miles, to about 25,000 square miles.

Proposed Western Reserves

Throughout the past summer, the Forestry Branch of the Department of the Interior has continued the examination of forest lands in the West. As a result, reports have been prepared, indicating the desirability of further increasing the forest reserve area in Manitoba, Saskatchewan, Alberta and the Railway Belt of British Columbia, by some 10,708 square miles —an increase of 43 per cent.*

Practically all of this land is reported as being non-agricultural and chiefly valuable for the production of timber. On much of it, fires have caused extensive damage so that the amount of merchantable saw-timber over considerable areas is relatively small. However, in addition to the saw-timber, which in the aggregate amounts to a great deal, there is a large amount of pulpwood and a vast area of young growth which, if protected from fire, will become of merchantable size while other resources are becoming exhausted. The relative accessibility of a great deal of this timber land to the new settlements in the Prairie Provinces makes reservation and protection very important. For these reasons, the areas recommended should be included within permanent forest reserves.†

Of the proposed additions, 72 per cent or 7,698 square miles, is in Alberta. About two-thirds of this, or 5,023 square miles, comprises

*For description of additions, see Appendix, p. 150 *et seq.*

†Since the preparation of this report, these additions have been made by Act of Parliament.

the proposed Lesser Slave Forest reserve lying south and west of Lesser Slave lake, and east of the trail between Edson and the Peace River district, the south boundary being the Athabaska river. The balance is made up of several additions to the Rocky Mountains reserve, the boundary examination of which had not been completed when the Forest Reserves Act was passed. The additions lie to the east of the present line, and consist largely of foothill country and muskeg.

Eight and four and a half per cent, respectively, of the total additions recommended are in Saskatchewan and Manitoba. These are spruce, jack pine and poplar lands, partly muskeg and partly sandy, of no agricultural value, but of great importance as potential sources of timber supply for large prairie sections. The timber in certain portions of the proposed additions is already disposed of as licensed timber berths, and on some of these areas extensive lumbering operations are being carried on.

Proposed Reserves in British Columbia

The areas in British Columbia recommended for addition comprise approximately 15.5 per cent of the total. This is mountainous, timbered land in the Railway Belt, and is of great importance as a watershed, draining into irrigation districts where water is essential to the best use of large agricultural areas.

Game Preserve in the Rocky Mountains

It is of interest to note that a recommendation is to be submitted by the Dominion Forestry Branch for the establishment of a game preserve in the southern portion of the Rocky Mountains Forest reserve. The proposed game preserve lies due north of the Glacier National Park, which is situated in the north-western portion of Montana, and which serves, also, as a game refuge. The establishment of a similar refuge in southwestern Alberta adjoining the Glacier National Park has for several years been advocated by the Camp Fire Club of America and by a considerable number of prominent men in Canada. The proposed action of the Forestry Branch would unquestionably assist materially in the conservation of wild animal life in the Rocky Mountain region.

It is also highly desirable that similar action be taken by the Government of British Columbia in the establishment of a game preserve in southeastern British Columbia, adjoining the area in Alberta to be covered by the game preserve recommended by the Dominion Forestry Branch and extending westward to the Flathead river, thus coinciding with the western boundary of the Glacier National Park.

Forestry in Nova Scotia

During the summers of 1909 and 1910, the Government of Nova Scotia caused an examination to be made of forest conditions in that Province, under the direction of Dr. B. E. Fernow. A brief summary of the situation was presented at the annual meeting a year ago, and the complete report on the examination has recently been published by the Commission of Conservation.

It appears that not more than 20 per cent of the area of the Province can be classed as even potentially agricultural, that 10 per cent is hopelessly barren, and that 70 per cent is actual or potential forest land, very much of which is now in poor condition, but is capable of restoration. At the present rate of cutting, the merchantable timber will be exhausted in from twenty to twenty-five years.

The importance to the Province of conserving its forest resources is clearly shown, and the recommendation is made that the Government appoint a technically educated Provincial Forester, to study the situation in the various localities and act as public adviser or instructor—a wandering teacher. It is recommended that the Commission endorse this recommendation and urge its adoption by the Government of Nova Scotia.

Similar action should undoubtedly be taken, also, with regard to New Brunswick.

Summary of Conclusions

It is recommended :

1. That the Commission approve the principle of co-operation between the Board of Railway Commissioners and the fire protective organizations of the Dominion and Provincial Governments in the administration and enforcement of the fire regulations of the Railway Commission, along the lines now in effect in the West and as proposed in the East.

2. That representations be made to the Dominion Government looking toward the establishment of a fire-protective service along the Intercolonial and National Transcontinental railways similar to that provided for in Order 16,570 of the Board of Railway Commissioners.

3. That the Governments of New Brunswick and Nova Scotia be urged to organize separate branches devoted especially to forest fire work, including all lines of railway fire inspection, as well as the handling of fire-ranging throughout the Provinces at large. Also that control be definitely taken over with regard to fire-protection along

provincially chartered railways, through the enforcement of existing legislation, or the enactment of new legislation where necessary.

4. That the Commission urge the Dominion and all Provincial Governments not now doing so, to consider carefully the question of brush disposal in connection with all new licenses and renewals of old licenses issued in the future. Especial care in this connection is needed to safe-guard the country along railways and wagon roads. Especially in Ontario, New Brunswick and Nova Scotia and in the Timber Branch of the Department of the Interior is the further development of a forestry organization essential in order to properly study and administer this feature of the work. The extension of the merit system of appointment and promotion is essential to efficient organization.

5. That the Commission approve the organization of co-operative fire-protective associations of limit-holders, and the principle of contribution by the Dominion or Provincial Government in proportion to the benefits received.

6. That the Dominion Government be urged to begin a systematic study of the extent and character of forest resources in the forest reserves, and other forest lands under its direct jurisdiction ; and that a similar course be urged upon the Provincial Governments of Ontario, Quebec and New Brunswick as to forest lands within their boundaries.

7. That the systematic collection of complete statistics of forest fire losses be urged upon the Dominion and Provincial Governments wherever this action is not now being taken.

8. That the Commission approve co-operation with the Government of Ontario in an examination of forest conditions outside forest reserves in the northern portion of that Province, south of the Clay Belt, and that favourable reciprocal action by the Ontario Government be invited.

9. That representations be made to the Dominion Government, urging that favourable action be taken with regard to the proposed additions to the Forest Reserves recommended by the Forestry Branch.

10. That the proposed establishment of a game preserve in the southern portion of the Rocky Mountains Forest Reserve, and in southeastern British Columbia adjoining the Glacier National Park, be endorsed ; and that favourable action be urged upon the Dominion Government and upon the Government of British Columbia.

Appendix

I.—Dominion Forest Reserve Extension

The attached list, prepared by the Dominion Forestry Branch, shows the proposed changes of area in the forest reserves. As will be seen, the present area of the forest reserves is 25,042 square miles, and if the additions are made there will be an increase of 10,708 square miles, a 43 per cent increase.*

The description of the additions is as follows :

Province of Manitoba

Duck Mountain Forest Reserve.—An additional 58.25 square miles is proposed, this being a tract of broken land partially covered with muskeg and with considerable timber upon it, there being scattered spruce and a considerable area of poplar. The chief reason for making this addition is in order to make the Shell river the western boundary of the reserve at this point, so providing a good natural fire-guard.

Porcupine Forest Reserve.—On the south and east slopes of the Porcupine Forest Reserve there was considerable broken sandy land which was not fitted for agricultural purposes and which now bears a considerable area of good spruce and jack pine timber. This area was carefully examined in the year 1910 and a recommendation was made that the broken slopes of the hills and the sandy lands west and south of the Canadian Northern railway comprising an area of 430.5 square miles should be added to the reserve. There is no settlement on the lands that are proposed to be added and their non-agricultural character is so evident that it is not likely that there would ever be any demand for settlement on them. Several large timber berths are located on the tract proposed to be included and these are now being operated extensively.

An examination has been made during the past season of the lands lying to the west of the reserve, but a final report on them has not yet been made. There is an addition of 204.75 square miles recommended, however, to the portion of the reserve known as Porcupine Forest Reserve No. 2, which lies in the Province of Saskatchewan. The part lying to the west of the reserve, as now constituted, which was examined during the past year contains the head waters of the Assiniboine river, and most of the main tributaries of that river are fed from the Porcupine, Duck and Riding Mountain Forest reserves,

*Since the preparation of this report, these extensions have been made by Act of Parliament.

so that those reserves form one of the most important watersheds in the Province of Manitoba.

Province of Saskatchewan

Fort a La Corne.—This is a tract of some 513 square miles lying along the Saskatchewan river, both on the north and south sides, in the vicinity of Fort a La Corne. At this point there is a row of sand ridges interspersed with muskeg which carries a stand of jack pine with some spruce. This sand ridge runs along the north side of the river and continues in a north-easterly direction for a considerable distance beyond the point where the inspection has been made. The soil is a light sand and is absolutely non-agricultural land. It is not of any value for any other purpose than timber growing. It has been cut over for ties and other purposes and the timber at the present time is not of great value, but the reproduction of jack pine is good, and it should be a very important timber tract in the future.

Pines Forest Reserve.—This is a sandy tract of land lying south of the Saskatchewan river, a short distance south-west of Prince Albert. The land is sandy except for a large muskeg which runs through the centre of it. The sand lands are timbered more or less with jack pine, although the cutting of ties and other timber, which was done very wastefully on this reserve, was followed by destructive fires which have left but little timber in some parts of it. At points where the fires have not reached, however, the reproduction of jack pine is good ; and on the lower parts spruce and tamarack are found ; and there is considerable young growth coming on. This is one of the most important reserves on account of its vicinity to an extensive prairie country, which is not extensively wooded, and on account of its being in the vicinity of the city of Prince Albert. It is proposed to add 73.15 square miles of similar sand lands on the edge of the reserve.

Nisbet Forest Reserve.—This is an extension of the same sand area included in the Pines Forest Reserve. This sandy tract crosses the Saskatchewan river at the north-west corner of the Pines reserve and then, turning in an easterly direction, follows the north branch of the river to a point a little to the east of Prince Albert. This land is all a very light sand which would become drifting sand hills if it were opened up to grazing or agriculture, and the only possibility of getting permanent value from it and at the same time preventing the danger of drifting sand is to keep it under timber and to handle the timber in such a way as to keep a forest cover regularly over the area. This tract was cut over for ties, and some parts of it are being cut over for firewood. As a consequence the timber of large size has all been taken out. There is however, a splendid reproduction of young

jack pine, which only needs protection to be a very valuable product in the future and to be of great protective value on these sand hills. This reserve will also furnish a park and pleasure ground for the city of Prince Albert, and will be of great value to the city for recreative purposes of all kinds. The rifle range for the military district with headquarters at Prince Albert is located on the reserve. This tract was carefully examined in 1911 and it is proposed to include an additional area of 60 square miles.

Province of Alberta

When the Rocky Mountains Forest reserve was established by the Forest Reserves Act, the examination of all of the boundary had not been completed. The examination has been continued since that time and it is proposed to add some additional areas to the reserve. In the southern part of Alberta, a little to the north of the Crow's Nest Branch of the Canadian Pacific railway, is a tract of land known as the Porcupine hills, which is separated by a narrow valley from the Rocky Mountains proper. These hills rise to a height of from 5,000 to 6,000 feet and have in places very good stands of spruce, lodgepole pine and Douglas fir. It is the centre of the grazing district where the annual precipitation is not very large and its value as a watershed is very great. Steps have been taken for the careful protection of this area from fire and it will be a great convenience to a ranching population in that vicinity, and the proposal for the reservation has their full support.

In the northern part of the reserve along the head waters of the Saskatchewan and Athabasca rivers the examination of the boundary had not been completed when the reserve was established by Act of Parliament, and the preliminary line was laid down in the statement. Further inspection however, has shown that additional lands should be included in the reserve, as the elevated foothill country extends very much farther eastward into the prairie in the northern part of the mountain range. The tract proposed to be included does not contain any large areas of mature timber but the land is high and open and in many cases carries extensive muskegs. The timber is spruce and lodgepole pine with occasional groves of Douglas fir. The growth on well-drained lands in this district is rapid, and its possibilities for the production of timber for the prairie districts is only limited by the possibility of protecting it from fire. During the past year the organization for protecting it from fire has been much more thoroughly worked out and considerable work in the building of trails and otherwise providing means of communication so that fires can be handled readily has been carried on. The total area proposed to be added to this reserve is 2,675 square miles.

The Lesser Slave Forest Reserve.—This is a tract lying to the south and west of Lesser Slave lake and east of the trail leading from Edson on the Grand Trunk Pacific railway to the Peace River district, the south boundary being the Athabasca river. This tract rises to a height of between 3,000 and 4,000 feet and there is a stand of spruce and pine scattered all over it. It is only in portions of it, however, that the stand is mature and heavy, but the indications are that the growth of timber on this tract would be fairly rapid, so that it could be considered as a very suitable tract for timber reproduction. Its elevation and the broken nature of the country make it unsuitable for agriculture. It could form one of the finest pulpwood forests in the whole of the West, and would probably equal that in any district in Canada. The great problem at the present time is its protection from fire. It is rather interesting to note that it is just at this point that the jack pine of the East begins to be replaced by the jack pine of the West, commonly known as the lodgepole pine. Both of these trees are found on this reserve. The area is 5,023 square miles.

Province of British Columbia

In the Railway Belt in the Province of British Columbia, which is under Dominion jurisdiction, there is an extensive tract from about Notch Hill to North Bend, a distance of some 170 miles, which has such a small precipitation that irrigation is required for successful agriculture. The protection of the watershed in this district is, therefore, of great importance and the forested mountain tops are of greater importance almost, than in districts where the supply of water is not such a pressing question. The Thompson and Fraser rivers run through this tract but in such low valleys that the use of their waters for irrigation is not very feasible. As a consequence irrigation in the vicinity of Kamloops and the other towns in the district is carried on from the small streams which head in the mountains within the Railway Belt. Several small reserves have already been established by statute, and the examination of the lands has been pushed on during the last few years in order to determine finally what lands are absolutely non-agricultural, and should be included in forest reserves.

In consequence of this examination considerable additions to the reserves have been recommended. The tops of the mountains are generally well wooded with balsam fir, Douglas fir, spruce and lodgepole pine, and on the lower portions of the hills the western yellow pine is found in scattered stands. The timber on these reserves will be of great value, but their value as reservoirs for water supply is perhaps the greatest at the present moment, as the necessity for water is more pressing than any other in that district and more necessary for the

development of the country. A central office has been established at Kamloops for looking after the organization and protection of these forest reserves, and several trails have been opened up and other work undertaken for the better protection of the reserves.

One of the most interesting features of the reserves is the beautiful little lakes found in them. One of these, generally known as Trout lake, in the Long Lake Forest reserve near Kamloops, has become quite a summer resort and is celebrated for its fishing. People from all parts of the world come there for that purpose. A portion of the shore of this lake has recently been surveyed and is being handled by the Forestry Branch as a summer resort. The area proposed to be added is 1,670.51 square miles.

Area of Forest Reserves

In square miles

	Present Area	Proposed New Reserves	Proposed Additions	
PROVINCE OF MANITOBA				
Riding Mountain	1535	.....	.....	
Turtle Mountain	109.25	.....	.....	
Spruce Woods	224.50	.....	.....	
Duck Mountain No. 1	1404	.....	58.25	
Porcupine No. 1	312	.....	430.50	
	3584.75		488.75	45%
PROVINCE OF SASKATCHEWAN				
Fort a la Corne	.....	513	.....	
Beaver Hills	99	.....	.....	
Pines	154	.....	73.15	
Moose Mountain	156	.....	.....	
Porcupine No. 2	360	.....	204.75	
Duck Mountain No. 2	81	.....	.....	
Cypress Hills No. 2	72	.....	.....	
Nisbet	14.94	.....	60	
	936.94	513	337.90	8%
PROVINCE OF ALBERTA				
Lesser Slave	.....	5023	.....	
Cooking Lake	111.50	.....	.....	
Cypress Hills No. 1	81	.....	.....	
Rocky Mountains	18213	.....	2675.30	
	18405.50	5023	2675.30	7.2%
PROVINCE OF BRITISH COLUMBIA				
Nicola	.....	*273	.....	
Long Lake	190	.....	*310.25	
Monte Hills	106	.....	77.50	
Martin Mountain	17.75	.....	16.25	
Niskonlith	125	.....	193.06	
Tranquille	149	.....	142	
Hat Creek	205	.....	134.07	
Larch Hills	25	.....	.....	
Yoho Park	723.50	.....	.....	
Glacier Park	574	.....	.....	
Fly Hill	.....	225.13	.....	
Mount Ida	.....	45.25	.....	
Arrow Stone	.....	254.00	.....	
	2115.25	797.38	873.13	15.5%

Total present area, 25,042.44 sq. miles.
Total additions 10,708.46 square miles.

* Approximately.

II.—Memorandum Regarding the Country Between Sudbury and Port Arthur

By J. H. White

The line of travel was from Sudbury to Port Arthur and to Sault Ste. Marie and northward on the Algoma Central. The method adopted was to note what could be seen from the train, and to stop off at possible sources of information. The only information of any value was that furnished by Crown timber agents and lumbermen. From Sudbury to Port Arthur on the C.P.R. there are but few operations located, since most of the drainage is towards James bay. In consequence, information of a definite character regarding the region north of the railway could not be obtained. More success was met with regarding the southern portion.

The region under consideration is a portion of the Laurentian shield surrounding Hudson bay. In general the rock is Laurentian gneiss and granite covered with a very thin soil, with some later pre-Cambrian areas from Sudbury westward to Sault Ste. Marie, between Michipicoten and Missinaibi, from east of Heron bay to Port Arthur and around lake Nipigon.

It is a country characterized by the monotonous uniformity of its physical features. It consists of a plateau broken by low hummocky hills and ridges rising at most only a few hundred feet above the general level, the valleys being occupied by lakes, muskegs, and streams.

(1) FROM SUDBURY TO PORT ARTHUR

From Sudbury to Port Arthur, generally speaking, the country along the railway has been burned at one time or another for the entire distance of 550 miles.* Not much has escaped except the spruce swamps. The burned areas have been partially recovered by temporary stands of poplar, white birch and jack pine, either pure or in mixture. But to a vast extent the country has been burned so repeatedly that there is nothing left but bare rock.

As to the amount of destruction north and eastward from the railway little is known. In many cases the fire has not run back over five to ten miles ; but in many others it has run back in streaks between waterways for great but unknown distances. In 1891 fire swept from

*See "Fire Losses in Ontario" by J. F. Whitson.

THE RESULT OF REPEATED FOREST FIRES ALONG THE CANADIAN PACIFIC RAILWAY
North Shore of Lake Superior, Ontario

Pogma station to Woman river, a distance of some 60 miles. Five years later this same territory was burned over again in a larger fire which swept the country from the headwaters of the Mississaga and Spanish rivers northward between Matagaming and Pishkanogama lakes to Flying Post. Much of this area was covered with white and red pine. West of this again, and north from Ridout to Chapleau, the fire has run back a long way destroying much white and jack pine. From east of Pardee to Windermere lakes the burn extends northeastward at least 15 miles. Other known burns are indicated on the map. From Heron bay westward the country is very rough ; it bears a growth of dwarf spruce, and is badly burned ; the rivers are short and drivable for only a brief time in the spring.

South and west from the railway, owing to the prevailing wind direction, the fires have not burned over as large areas. From Dalton to Grassett southwestward, however, the country has been badly burned. Outside of the birch-poplar types resulting from fire, of some tamarack swamps that have escaped the saw-fly, and of some scattering white and red pine groves, the whole region is distinctly a spruce-jack pine type, the spruce occupying the muskegs and swampy flats, the jack pine the sandy plains and rocky ridges. The wooded areas, however, occur only in patches here and there. The trees in many places have attained a size suited for pulpwood and ties. In the eastern half of this territory from Woman river east, some white pine operations are still in existence, notably on Biscotasing waters and eastward to Onaping lake. The mills to be found along the railway manufacture approximately a total of 10 million feet of pine and a quarter million ties.

The sparse settlement is confined entirely to the railway line, the majority of the people dependent upon employment with the railway company. Outside of some low wet farms for some 25 miles west from Sudbury and scattered patches along the Lake Superior portion of the railway, absolutely no attempts to farm are to be seen.

(2) FROM SUDBURY TO SAULT STE. MARIE

The territory from Sudbury west to Sault Ste. Marie is very different, for here the white pine type prevails—the western end of the Canadian commercial pinery. The whole region has been under license, and never having been as heavily timbered as the Ottawa valley, is now pretty thoroughly culled. In consequence it is to-day a mixed forest of white and red pine and hardwoods. Along the railway are scattered farms with a considerable farming district from lake George eastward to White River.

This territory has also suffered severely from fires. As early as 1864 the whole north shore, known to have been green as late as 1857, was burned from Bruce Mines to Wahnapitae river. In 1871 fire swept over the country from south of the French river up the Sturgeon and westward to the headwaters of the Vermillion, Spanish and Mississaga rivers ; over 2,000 square miles are estimated to have been burned. Mr. J. F. Whitson of the Department of Lands, Forests and Mines, Ontario, estimates that fire in the last 50 years has reduced the pine area north of lake Huron by one-half.

North of the central portion of this region lies the Mississaga Forest Reserve of 3,000 square miles, mostly white and red pine and burned in various places to the reported extent of at least one-half the area. In this reserve four townships in the southeast have been licensed.

(3) FROM SAULT STE. MARIE NORTHWARD

This route is open only as far as the Batchawana river. The southern part of this region continues of the same forest type as just described, but is more largely hardwood (sugar maple and yellow birch principally) with scattered aged white pine. Much of the hardwood is over mature, and only the birch is suitable for manufacture into lumber. At present much cordwood is cut for charcoal manufacture in Sault Ste. Marie.

Travelling northward the pine and hardwood gradually drop out, until after some 50 miles, about the Agawa river, the type passes over into the spruce type of the country farther north. Besides the spruce there is considerable cedar, with also balsam fir and jack pine.

This region has been surveyed by the Algoma Central Railway Company, whose line traverses the middle and will eventually reach the G.T.P. For building the railway the Company has a land grant of 81 townships. Practically the only lumbering on this territory has been that of the Algoma Central, now transferred to the Superior Pulp Company with large mills at Sault Ste. Marie, using some 40,000 cords of spruce yearly.

As regards fires this region has not been quite so severely burned. The southern portion for some 20 miles, or as far as settlement extends north from Sault Ste. Marie, has suffered somewhat, as well as the northern part towards the C.P.R. The country between these sections is mostly still green timber. Surveyor A. P. Salter in the report of his 1867 base line from Michipicoten eastward describes the devastation even at that early time, stating that "the country north of my line along the Height of Land is now for an area of 2,000 square miles a desolate wilderness."

Here again the amount of land suited to agricultural use is negligible, though settlers are found scattered as far north as Wa Bos township.

SUMMARY

The whole territory south of the Clay Belt lying between the Timagami and Nipigon reserves is one pre-eminently suited for creating a forest reserve to be managed on forestry principles, the northern part for its spruce and jack pine, the southern part for the white pine reproduction. Of the forest reservations in existence, Timagami (5,900 square miles) and Mississaga (3,000 square miles) have been set aside to conserve the white pine, and Nipigon (7,300 square miles) mainly on account of the spruce pulpwood. The agricultural areas within this whole territory are practically negligible, the land being absolute forest soil ; and settlement so far very slight. Outside of the townships lying between Sudbury and the Sault, the 81 townships along the Algoma Central, 96 square miles along the Black river near Heron bay, and some 3,000 square miles of the headwaters of the Spanish river practically all is unlicensed. The land is fit only for growing trees, and while it may be claimed that there are vast quantities of spruce north of the Height of Land the commercial quantity is largely on agricultural soil from which it will be removed once and for all. The jack pine is needed for tie timber and one is impressed with its persistence in spite of fires throughout the whole northern portion. If the fire devastation were once stopped, the future of the region is assured. The region directly north and east of Sudbury was not examined but it is known to be of the same general type of white pine country. South of the Timagami reserve are some townships tributary to the Sturgeon river and still in the Crown, estimated to contain two billion feet of white pine. For a rational use of the soil the region from Mattawa west to Nipigon, with the southern boundary of the Clay belt running from the Porcupine district to Nipigon reserve as northern limit should be made into a reserve and adequate expenditure for fire protection made. All representative men encountered on this trip without exception agreed that this region should be placed in reserve for timber growing. It will, however, in all probability be necessary and desirable to make a further and detailed examination with a view to securing specific information as to just what sections should be first considered in connection with the plan of permanent reservation suggested herein.

III.—Opinions on Oil Fuel

New York & Ottawa Railway Co.—Our tracks pass through 36 miles of the Fire Preserve section through which, from May to October, inclusive, locomotives are required to burn oil.

In the year 1910 we installed oil burning device on two locomotives at a cost of $950.00. During 1912 the following expense was incurred :

Changing locomotives from coal to oil and then from oil to coal	$ 389.22
Maintaining Fire Patrol	1,923.83
Clearing Right of Way of stumps, undergrowth, etc.	3,316.18
Increase in cost of oil over coal	5,868.10
Total	$ 11,497.33

The cost of oil was 3.308c. per gal.

Locomotives started no fires in 1912.

Chicago, Milwaukee & St. Paul Railway Company.—Figures have been compiled from time to time on the cost as between use of fuel oil and coal and as near as we can determine, the use of fuel oil is about one-half cent per ton cheaper than coal. Three barrels of oil is considered equivalent to one ton of coal.

Bellingham & Northern Railway Company.—The oil has been entirely satisfactory from a fire preventive point of view, and we estimate a saving of approximately 33 1/3 per cent of fuel consumption, as compared with coal, but you will understand that we are so situated that our coal has cost us an unusually high freight rate.

Tonopah and Goldfield Railroad Company.—The T. & G.R.R. does not operate through any timber country at all, our entire mileage being over sandy desert country, however, our observation is that oil is satisfactory as a fire preventive measure. Oil prices in this territory range from 38c. to 58c. per barrel at the oil fields, to which is to be added freight charges, and our experience is that the cost of fuel oil as compared with coal is just about one-half.

SOUTHERN PACIFIC COMPANY

Extracts from "Rules and Information for the Handling of Oil-Burning Locomotives."

7. Guarding Against Fires.—Especial care should be exercised by roundhouse foremen and engine watchmen, to prevent accumulation of carbonaceous matter in fireboxes, so that liability of setting fires will be avoided. Engineers observing live sparks escaping from smoke stacks will report this at once to superintendent and master mechanic by wire ; also on work book on arrival at terminal roundhouse

Carbonaceous matter is formed on side sheets when burner is out of alignment, pan leaking air between brick-work and boiler sheets, and any obstruction between burner and wall of fire-box. This may be later carried through the stack by the exhaust steam and is liable to cause fire.

The throwing of pieces of waste or other inflammable material on deck of engines, where it will be carried into the firebox through the fire door, is liable to set fires. Sand should be carefully examined for bits of charcoal, sticks, sea-weed and other inflammable material. Enginemen must report condition of same at any point if found to contain any inflammable matter.

9. Improper Sanding.—The engine should be well sanded in going from roundhouse to train, where practicable ; and again in pulling out of stations. This is very important, as engines are liable to be smoked up in starting the fire and around terminals. Keep on sanding as long as quantities of black smoke follow the act of sanding, giving the scoop a lateral motion in order to clean the side flues as well as those in centre.

Care should be taken by firemen in sanding flues that only such amount is used as may be necessary to remove the soot. This should be done on road when the engine is working hard enough to draw the sand through the flues. Engineers should take pains to give the valves sufficient travel, and open the throttle far enough so that the exhaust will carry the sand through the flues and do the work for which it is intended.

Enginemen must use judgment to avoid sanding and possible throwing out of burning soot from stack, at places where inflammable material is adjacent to track.

12. Enginemen must also remove material used for starting fire, as it may be drawn through the stack by force of exhaust steam, and is liable to set fire. Too much attention cannot be given to this rule.

16. Proper Roundhouse Inspection of Oil-Burning Locomotives.—On arrival of oil-burning locomotives at roundhouses, thorough inspection of the brickwork should be made, especially seeing that the bottom of the firebox is free from any obstruction of brick or carbonization.

See that joints between the pan that carries brick work and fire-box are absolutely air-tight.

Bafflers to be in good condition and properly adjusted.

Burners to be kept thoroughly clean.

Flame from burner should be spread centrally.

Smoke-boxes should be absolutely air-tight.

Steam pipes and petticoat pipes should be examined thoroughly.

Flues under burner should be cleaned out thoroughly.

No lost motion should be allowed in firing device.

Sand in sand-box used for sanding flues should be fine sand, thoroughly screened, dry and free from foreign materials.

From "Don'ts."

In view of the fact that fuel oil is used exclusively on this system, it is desirable that all concerned become thoroughly familiar with the apparatus pertaining to oil-burning locomotives, to the end that slight defects may be promptly remedied and success in its use assured.

E. T. Allen, Forester for Western Forestry and Conservation Association.—From what I have heard, I should say that the risk does not demand patrol. Moreover, that if escape from patrol expense can be offered companies in return for converting to oil it would tend to safety, more than leading them to believe that, whether or not they burn oil they must still patrol. I have heard the theory of superheated waste products before, but always felt like attributing it to a desire to belittle the oil fuel movement.

Esquimalt and Nanaimo Railway Co.—The fuel oil in use by the E. & N. Railway is delivered by the Union Oil Co., of California into our oil tank at Esquimalt at 77c. per barrel of 42 U. S. gallons.

The average price of coal delivered on tenders E. & N. Railway, is about $3.75 per ton.

REPORT ON C.P.R. OIL BURNING LOCOMOTIVES

CALGARY, NOV. 23rd, 1912

A. J. NIXON, ESQ.,
Chief Operating Officer, B.R.C.,
Ottawa, Ont.

DEAR SIR,—

I beg leave to submit the following report on the C.P.R. oil burning locomotives assigned to the divisions east and west of Revelstoke. In making a close inspection of the fire pans on the above class of locomotives, I find that a great deal of carbon forms on the side sheets of fire-box ; also on splash wall, and in travelling on several locomotives at night, I see that this carbon breaks off and is carried to the atmosphere in the form of sparks, which in my opinion are just as liable to set fire to the right-of-way as coal sparks.

The reasons I would give for this carbon forming are as follows : First,—burner getting dirty, caused by impurities and foreign elements in the oil.

Second,—burner not being in line ; that is, flame striking flash wall too much to one side, or too high or too low.

Third,—loose bricks falling out and obstructing flame from striking flash wall squarely.

The Company is experimenting to do away with the above defects and as sparks from a locomotive cannot do any harm for the next five months, I would advise that they be given that length of time to better the conditions, but at the end of that time if there is no improvement, I would recommend that all dead plates and netting be put back in front ends.

Since the conversion of these locomotives from coal to oil burning there have been a great many leaks developed in the boilers such as crown bolts and side sheets leaking badly. I am of the opinion that it would be advisable to have several of these locomotives given the hydrostatic test.

Yours truly.

A. E. HUDSON,
Inspector B.R.C.

Copy of Letter from the Director of Mines and Report by Edgar Stansfield

Department of Mines
Canada

Ottawa, Jan. 17th, 1913

Dear Sir,—

In conformity with your request of the 13th instant, the sample of carbonaceous scale was analyzed by Mr. Edgar Stansfield, our fuel testing chemist, and submitted by him to certain tests.

It seems to me that the formation of this scale could to a very large extent, be avoided by a mixture of the oil spray with air in such proportion as to ensure complete combustion.

I enclose Mr. Stansfield's report.

Yours very truly,

Eugene Haanel,
Director of Mines

James Ogilvie, Esq.,
Asst. C.O.O., B.R.C.,
Ottawa.

[copy]

Report of Examination of Material from Inside of Fire Box of Oil Burning Locomotive. Sample received from Mr. J. Ogilvie, Operating Department, Board of Railway Commissioners for Canada

Analysis showed that the sample was a very hard, impure form of carbon, almost free from hydrocarbons. A proximate analysis carried out in the manner customary for coals, showed 88.8 per cent fixed carbon, 5.0 per cent volatile matter, 5.7 per cent ash, and 0.5 per cent water.

The sample was in the main combustible, but only burned with considerable difficulty. Small pieces heated in a quartz tube to the ignition point burned very readily in a current of oxygen, and continued to burn after the external heat was removed. If air was passed through the tube instead of oxygen the pieces tested burned slowly as long as the tube was kept hot, but combustion ceased when the external heating was discontinued.

A larger sample strongly heated in a blowpipe flame burned very slowly while the flame was actually impinging on it ; when the flame was removed, the material appeared to cool as rapidly as it would have done had it been non-combustible.

In conclusion it may be stated that the material closely resembles retort carbon, and as far as can be ascertained from small scale laboratory tests, incandescent pieces thrown out from the smoke stack of a locomotive would be but little more likely to cause fires than similar pieces of incandescent non-combustible material.

(Sgd.) EDGAR STANSFIELD

January 16th, 1913

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